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BURGLAR ALARM FOR SAFES.

FREDERICK A. DRAPER.

The numerous and daring robberies repeatedly chronicled in the daily papers, where stores, banks and post offices have been entered, the safe blown open and contents taken, would seem sufficient in the way of warning to influence those having valuable property to protect it, especially when this can be done with comparatively little expense and trouble. That is, it can be protected to the extent that an alarm can begiven of an attempted robbery, either on the premises or at a point at a distance, such as a fire or lighting station, or other place where men are on duty both day and night. The fact that a safe or other depository is protected in this way is generally sufficient to prevent any attempt at robbery, and an "ounce of prevention is worth a pound of cure."

The device by which an alarm is given in the event of interference from any cause is here described. It comprises two electrical circuits of differing strengths, working through relays located at the point where an alarm is to be given. Any decrease in the stronger circuit, or increase in the weaker one will cause either one or the other of the relays to make contact and

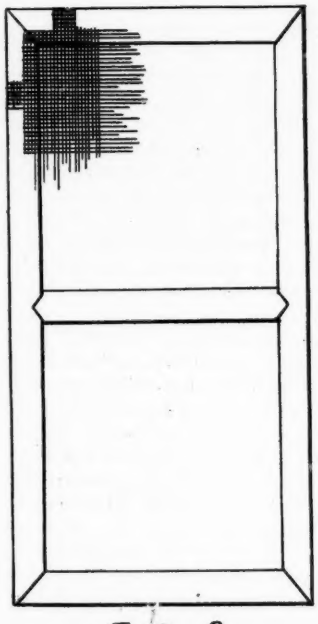

FIG. 2.

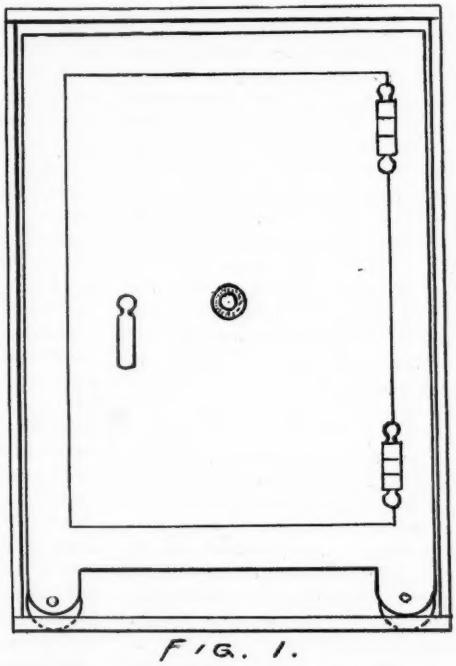

FIG. 1.

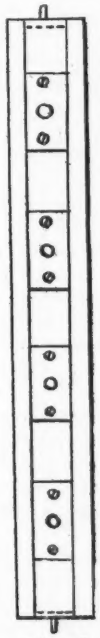

FIG. 3.

close a local circuit and ring a bell until a drop has been replaced or the battery run out. Another arrangement of two circuits is with one circuit closed and the other open, but the latter is not so efficient as the former. With the first system any break in the stronger circuit or "ground" between the two will operate on the relay, therefore the wires cannot be cut, crossed, or circuits diverted from the point protected without operating the relay. In fact, with this system a safe is not necessary, except as a protection against fire, or to retard robbers until those hearing the alarm can arrive and learn the cause.

Assuming that it is a safe which is to be protected, it is necessary to build a box of peculiar construction large enough to entirely surround the safe without touching it. In making this box, the principal object to be looked after is that no "grounds" are made by tacks, nails or screws between the wiring of the two circuits in the walls of the box. They are composed of two layers of wire screening, insulated from each other and held by a wooden frame. The screening can be obtained of any hardware-dealer.

Each side of the box is made in a separate section, all to be joined about the safe as shown in Fig. 1. The framing of a side is shown in Fig. 2, each frame being made of three thicknesses: a center one $\frac{5}{8}$ in. thick, and two outside ones $\frac{1}{4}$ in. thick, all about $2\frac{1}{2}$ to 3 in. wide, according to the size of the box; no great strength, only stiffness, being required. Only general dimensions will be given, as the requirements will differ so greatly with each case. It is advisable to make drawings of each part with dimensions before beginning construction so that contacts may be correctly located.

The sides, front and back all rest upon the floor section, with outer edges flush. The front and back lap the sides, the side on which are the hinges of the safe door, coming only to the front line of the safe to permit of swinging the door wide open, that side of the front section having a projecting piece to fill in. The top, bottom and sides project beyond the safe far enough to clear projecting, parts like the knob, by at least $\frac{1}{8}$ to $\frac{1}{4}$ in. The top and bottom also lap the front, which is removed to one side during the hours when the safe is open.

The construction of one section, a side, will be described. As before mentioned, the frame work is made in three thicknesses. A plain, rectangular frame is made with mitred corners and center brace of stock $\frac{1}{2}$ in. thick, as shown in Fig. 2: all joints should be glued. This frame is then covered on each side with the screening, the kind ordinarily used for screen doors will answer. Where joints are made on the front edge with contact plates it will be necessary to remove the paint covering the wire with a blow torch or potash. The covers of screening should be large enough to extend, where connected to the contact plates, and with corresponding projections on the bottom sections, a trifle less than $\frac{1}{4}$ in. beyond the sides of the wooden frame. At the corners it is cut away for about 2 in. each way to a little less than the frame.

After tacking the screening to the frame both sides are covered with heavy paper, which is laid on with a strong paste or thin liquid glue. The layers of paper are to insulate the wire coverings from each other.

The screening is put on with galvanized iron tacks, on a line marked with gauge or pencil and located to clear the tacks to be put in on the other side by about $\frac{3}{4}$ in. long, so that by no possibility can a point come through and "ground" one side with the other. The frame is now turned over, the open spaces are partly filled with straw board, excelsior or other non-conducting substance, so that in the event of moving things about and the box becoming indented, the two surfaces would not come in contact to form a "ground." This done, the screening for this side is then tacked on. A test for "grounds" can be made with a common bell and battery, one lead placed on one wire and one on the other. If the bell rings, or the hammer even vibrates, there is a "ground" which must be located and removed before proceeding further. This trouble is not likely to occur if care is used in driving the tacks.

The double screen frames are now covered on the outside with cartridge paper or other attractive covering and after nailing the sections together the outside frames are added. These are made of $\frac{1}{4}$ in. stock with mitred corners or halved joints as preferred and for the sides are the same size as the inner frame. They are fastened to the part already made with $\frac{1}{2}$ in. wood screws, countersinking the heads. Use plenty of screws of small gauge, covering with putty when all is completed. The projecting edges of wire are then soldered to the contact plates, to be described later, four or more being placed on the front edge, as shown in Figs. 4 and 5. The edges, other than the front, are simply soldered together, using care that no stray wires or drops of solder cause a "ground." The joints between sections are carefully nailed.

The contact plates are shown in Fig. 6 and will have to be made up, as they are not commonly on sale of the size and shape needed. Obtain some strip brass $\frac{5}{8}$ in. wide and about $\frac{1}{8}$ in. thick, cut into 32 pieces 2 in. long. Drill holes in the center of one-half of them of tapping size for $\frac{1}{4}$ in. rod, and cut threads with tap. Also drill holes in the center of the other half a trifle over $\frac{1}{4}$ in. diameter, say 9-32 in. Holes are also drilled at each end of all the pieces and countersunk to receive the screws for fastening. Get some $\frac{1}{4}$ in. brass rod from which 16 studs are made to fit into the $\frac{1}{4}$ in. threaded holes. These studs should clear the plate about $\frac{5}{8}$ in., the best way to make them being to cut the thread with a $\frac{1}{4}$ in. die, put on the plate and head over on the under side as with riveting, and then cut off the rod with a hack saw, finishing with a file.

The top, front and back sections are constructed in the same way, with wire projecting at several places with which to connect one section with another, ex-

cept the front one, on which are put the contact plates as described. These are located on the inner side, four to each edge, two being connected to the inner screening and two to the outer screening, alternating them. The plates with the studs are put on the front section. The screening is soldered to the bottom of the plates before they are screwed down. These plates are put on the framework, or the sheathing with which the inner side of the front section is covered. On the hinge side of this section, a board wide enough to reach the side section is nailed, the contact plates being put on the edge of this board and the wire screening connections carried down to the under side of the plates.

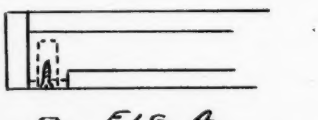

FIG. 4.

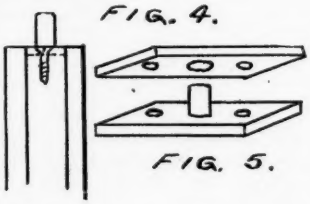

FIG. 5.

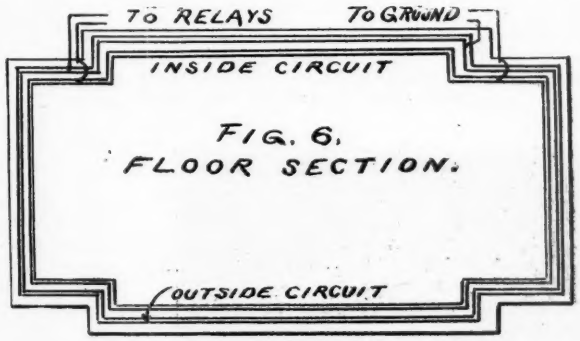

FIG. 6.
FLOOR SECTION.

The front of the top section will also require that the front two inches be a plain board, hinged to the rest of the top, so that it may be lifted off from the top of the front section, otherwise the studs would prevent the front from being put in place. To electrically connect this hinged piece and the rest of the top, use four ordinary burglar alarm door springs which are set into the hinged piece and make contact with flat pieces on the edge of the top. These door springs are connected with the contact plates by insulated wire, all joints being soldered.

The floor section will have to be shaped to fit between the feet of the safe, and the two covers of wire can be dispensed with. Make a solid frame of matched boards with 2 in. cleats at the ends, the boards at front and back to be loose until placed in position. Brass angles are then to be located at the edges to make contact with the other sections resting thereon, and these angles connected electrically as shown in Fig. 7, which also shows the leads to the line wire, grounds and day loop.

Another way of finishing the outside of the box, after all wiring has been done and connections made and tested, would be to sheath it all over with thin matched sheathing, which would be more durable than the wall papering mentioned, but much care must be taken to avoid short circuits.

The electrical connections, instruments and operation will be described in the next number.

A SIMPLE PASTE.

A simple paste, easily made and that will keep year, is made as follows: Buy at the druggist's an ounce of the best gum tragacanth. Pick clean and put in a wide mouthed glass or white ware vessel that will hold a quart. Pour on a pint and a half of clear, cold soft water. Cover the jar and let stand until the next day. The gum tragacanth will then be swollen and nearly to the top of the jar. Stir it down to the bottom with a stick and add two or three drops of the oil of wintergreen or sassafras. I prefer the former. This will prevent the paste from becoming sour or mouldy. Stir it several times during the day, but afterward do not stir it at all, leaving it to form a smooth white mass, like very thick jelly. Cover closely and set away for use, or you may take out as much as will fill one of the jelly tumblers with a cover, and keep it on your desk, handy for use. I have made this paste for several years and never lost any. I have kept it two or more years, and it has always been sweet and never mouldy. It does not turn yellow in scrapbooks, and is the best all around paste I have ever used. The gum will cost you 5 cents, and 5 cents worth of the oil of wintergreen is enough to last several years.

When melting babbit metal, care must be taken not to overheat it, or the more easily melted constituents will partly evaporate, leaving the alloy in bad condition. Melt a small portion first and gradually add to it until all is melted. Then skim off the top and the metal is ready to pour. Before pouring the metal wrap a sheet of smooth, thin writing paper around the shaft or other journal to be babbited, and secure it by winding a string spiral, in turns, ½ in. apart. Then put in the bearing and pour the metal. The paper prevents the cold iron from too quickly chilling the babbit and gives it a smooth surface, while the grooves made by the string make good oil conduits. If this is properly done, the journals will fit the bearing nicely and will not require scraping.

PHOTOGRAPHING ELECTRICAL DISCHARGES.

BY A HOBIEST.

Like most of the human race, I have hobbies, and one of them is photography. In this most interesting pursuit I delight in attempting unusual subjects, overlooked by the eagle eye (or less) of my fellows. I suppose that the reader gathers from this that I dabble in the outskirts and leave the more serious phases for those better qualified to handle them, and this I will not dispute, at the same time I find much of beauty in some of the unexplored corners.

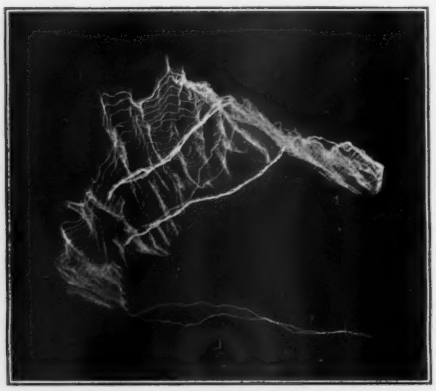

FIG. 1. DISCHARGE OF 1,000,000 VOLT TRANSFORMER. FLAME 10 FEET LONG.—By Percival E. Fansler.

In my profession as an electrical engineer, I have often marvelled at the strange outbreaks of this wonderful form of energy and have often wished that it were possible to record on a photographic plate, the brilliant manifestations of power accompanying high potential discharges. Recently, taking advantage of an exceptional opportunity, I made careful photographic study of phenomena produced by

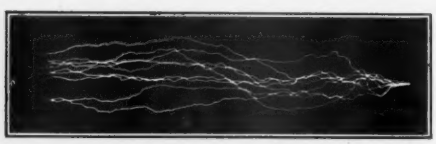

FIG. 2. DISCHARGE OF 50-INCH INDUCTION COIL. SPARKS 48 INCHES LONG.—By Percival E. Fansler.

appartus second to none in the world, and the pictures accompanying this article are typical, representing several distinct types of discharges. Before taking up the pictures in detail I might say that an electrical discharge results when two bodies, at a difference of potential or at a difference of electrical pressure, are separated by a medium, the dielectric strength of which is too low to withstand the strain imposed upon it. In other words, if we have a water pipe, closed at the end with a wooden plug, and if the pressure of the water is increased, a point is reached where the plug is forced from its seat, and the pressure is released.

This is precisely what happens when the secondary terminals of a transformer are brought into too close proximity; the difference of electric pressure existing between them is so great that the air gives way and we have an electric discharge or spark, the character of which varies with the conditions. An appreciation of the figures to be given may be gained from the statement that the pressure between the wires of an ordinary electric light circuit is 110 volts, and that it takes about 25,000 volts to jump an air gap of 1 inch. Fig. 1 is the discharge of a 1,000,000

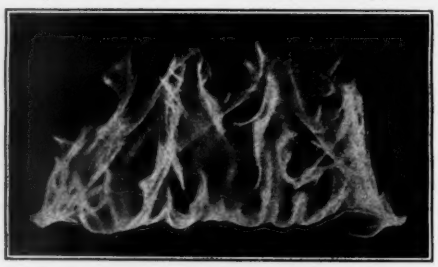

FIG. 3. FLAMING DISCHARGE OF 250,000 VOLT TRANSFORMER.—By Percival E. Fansler.

volt transformer, the highest pressure transformer, by three-fold, ever built. It was designed by the electricial engineering department of Purdue University, and will be used in research work. Over 100 h. p. was required to create the discharge shown, for which the terminals were separated five feet.

The photograph was made in the open air and the wind blew the flame out to the length of nearly ten feet. The terminals consisted of two brass rods held vertically on long glass arms, the lower ends 5 feet apart, the under about 6. On closing the switch a brilliant discharge occurred between lower ends of the rods, disappearing instantly, to be followed by others at intervals or 1-120 second, each a little higher than the preceding, owing to the fact that the heated path had a tendency to rise. This accounts for the

ribbon effect, each individual discharge with its accompanying heat band being clearly defined. The exact exposure may be calculated by counting the number of discharges and figuring 120 to the second; in fact, this is an excellent although impracticable way of calibrating shutters.

Fig. 2 is from a similar but smaller transformer of the same type, operating in still air, and producing a more unbroken impression.

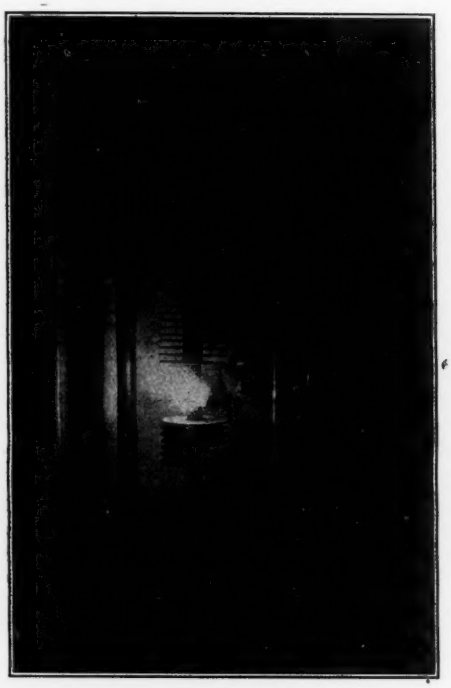

FIG. 4. SPARK GAP OF DE FOREST WIRELESS TRANSMITTING STATION.—By Percival E. Fansler.

Fig. 3 is the discharge of the largest induction coil in the world, one capable of giving a spark 60 in. long, or 18 in. longer than the classic Spottswoodie coil. This spark differs from the first two in that it is of a much higher frequency; that is, as many as 2000 distinct discharges may occur in a second.

The last picture, Fig. 4, is the spark produced in a DeForest wireless telegraph station, and was taken when messages were being transmitted from St. Louis to Chicago, a distance of 460 miles.

The discharge, unlike the others, was through but a short distance the terminals of the 60,000 volt transformer being separated but an inch, yet 20 h. p. was dissipated in the rupture and the copper flanges and air blast shown indicate the amount of heat generated and dissipated. This is, to me, a wonderful picture, lacking, it must be admitted, in composition, and with other faults, and yet it vividly portrays the utilization of a vast amount of energy for the needs of man, and in a most fascinating and spectacular way.—"Photographic Times."

TINY WORKING MODEL ENGINE.

A tiny working model of a triple expansion engine, made by Robert Bunge of New York, is perhaps the finest piece of skilled work of its kind that has ever been brought to the attention of our contemporary, the the "Scientific American." The engine measures 3¼ in. across the bedplate, and stands 3¼ in. from the bottom of the bedplate to the top of the cylinder covers. Every part is perfect. It is even equipped with the link reversing motion. With a steam pressure of 100 b., 7200 revolutions per minute are made, turning screw 2½ in. in diameter by 7 in. pitch. The high-pressure cylinder is 5-16 in. in diameter, the intermediate cylinder 8-16 in., and the low-pressure cylinder 10-16 in. The valves are of the regular piston type for cylinders, and measure 5-32 in., 7-32 in. and 9-32 in. in diameter. The shaft, the crank and the crank-pins are all turned from one piece of steel, which in itself is rather a neat piece of work. The eccentrics are split and are exact miniature duplicates of those used on engines actually in service. The nuts used in the construction of the model are for the most part a fraction less than 1-16 in. in diameter, and yet each is perfectly hexagonal. The studs are a little less than 1-32 inch in diameter and are threaded at both ends, one end screwing into the machine and the other receiving the nuts. The crossheads are made of steel, and are fitted with brass shoes that can be taken off whenever wear occurs. The steam pipe is ¼ in. in diameter, and the exhaust is 3-16 in. in diameter. The maker may well claim for this model that it is the smallest triple-expansion engine in the world.

MUST HAVE EYES TO FIND WAY.

In China many hundred of people live their entire lives on boats. Among them there is a strange idea that a boat must have an eye painted on its bow in order to see its way through the water. An Englishman traveling in China sat in the front of a small boat with his feet hanging over the painted eye. The owner became very much excited and begged the traveler not to cover the eye of the boat, as it must see its way. When the first railroad was built through China the native workers wanted to paint an eye on the front of the locomotive. They regarded it dangerous to have so fierce an appearing thing tearing its way through the country without an eye to guide its course.

BOOKS RECEIVED.

DIES; THEIR CONSTRUCTION AND USE FOR THE MODERN WORKING OF SHEET METALS. By Joseph V. Woodworth. 384 pp. 9 x 5¼ inches. 505 illustrations. Price $3.00. The Norman W. Henley Pub. Co., New York.

The use of the power press for the cheap and rapid production of sheet metal parts has progressed at such a pace during the last few years that a comprehensive book upon the above subject is at once of the greatest value to every mechanic engaged in work calling for use of dies. Competition is now so keen in manufacturing work of this kind that the most approved of modern methods are necessary to those who would attain or maintain supremacy, consequently this book upon the construction and use of dies is of great value. In writing it the author aimed to give practical men a complete presentation of all parts of the work, the fixtures and devices in use, from the simplest to the most intricate, together with numerous examples of work fully illustrated in the different stages of production. These are described in such a clear manner that all grades of metal working mechanics will be able to understand how to design, construct and use them, and all who may be in any way interested in the manufac ture of sheet metal parts may learn the best tools and processes to use.

While this subject is rather advanced for manual training schools, the book is one which would be very useful for reference and supplementary reading by those expecting to take up mechanical work upon graduating, and should be added to the list of every public library having funds for purchasing it.

AMERICAN TOOL MAKING AND INTERCHANGABLE MANUFACTURING. By Joseph V. Woodworth. 535 pp., 9 x 5¼ inches. 601 illustrations. The Norman W. Henley Pub. Co., New York.

To the machinist who expects to attain to position above that of the ordinary workman, a knowledge of tool making, as applied to interchangable manufacturing, is pretty nearly an absolute necessity. To such a one, as well as the manufacturer, this book will be of great value. The supremacy accorded the machinery made in this country is to quite an extent due to the fact that the feature for interchangable parts governs whenever it has been possible to have it. This is now so generally demanded as to make it necessary that tools be manufactured by processes which will produce this result. The author of this book fully recognized this, and arranged the text and illustrations to give accurate and concise descriptions of the fundamental principles, methods and processes by which the greatest accuracy and highest efficiency could be obtained in the production of repetition parts at a minimum of cost. He also describes and illustrates a large number of special tools, together with their construction and use, as far as space would permit. All of which is done in a clear, practical way, which can easily be understood by the reader. The manufacturer, the practical machinist, the technical instructor and intelligent apprentice will alike find this an indispensible text-book, the careful study of which will be of the greatest profit.

THE STANDARD ELECTRICAL DICTIONARY. By T. O'Conor Sloane. 682 pp., 7 x 5 inches. Price $3.00. The Norman W. Henley Co., New York.

The practical electrician and student will both find this dictionary a handy book of reference. While as compact as the subject will permit, yet the system of indexing and the use of synonyms following a subject enable the reader to quickly follow up any particular line upon which information is desired. As the present is the tenth edition, the usefulness of the book needs no further evidence.

PATTERN MAKING AND FOUNDRY PRACTICE. By L. H. Hand. 145 pp. 6½ x 4¼ inches. 104 illustrations. Flexible leather. Price $1.50. Frederick S. Drake & Co., Chicago, Ill.

The author of this book, a practical pattern maker familiar with all branches of the subject, has condensed into the limits of a pocket manual numerous examples and a great deal of information upon this important subject. In particular, several examples of railway car parts and some structural shapes are noted. The practical experience of the author is in evidence throughout the book.

THE ELECTRO-PLATER'S HAND BOOK. By James H. Weston. 278 pp. 6½ x 4¼ inches. 50 illustrations. Flexible cloth. Frederick S. Drake & Co., Chicago.

This book has been written to meet the requirements of platers desiring a practical and yet non-technical work on electro-plating. Platers of practical experience have been freely consulted in its preparation, thus giving to the contents a wider range of adaptability than is frequently the case with handbooks of this kind. The directions for the various operations are clearly given and suitably illustrated.

To fit boys to become apprentices in the shops of the Pennsylvania R. R., the board of education of Altoona has adopted a special course of instruction in the high school of that city. The plan is indorsed by the Pennsylvania officials, who co-operated with the school authorities in preparing the new course of instruction.

Russia is the fortunate country which produces about ninety per cent of the world's platinum. The remainder comes mainly from Columbia, South America.

Send a postal for the new premium list, now ready for mailing.

A CHEAP NINE-INCH REFLECTOR.

M. A. AINSLEY.

VIII. Mounting and Adjustment of Lenses.

As it will be necessary, in order to finally test the performance of the mirror in the telescope, to get it into good adjustment, I will briefly describe how this is done.

It is necessary, in order that the definiteness of a star may be as good as possible, that the image should be axiel— *i. e.*, should lie on a straight line joining the center of curvature to the center of the mirror. Of course, the image is actually formed at one side of the tube and outside it; but this image is merely the reflection of an image formed in the axis of the tube. The first thing is to get the center of the flat exactly level with, and central in, the e. p. tube. The disc of brass before mentioned, with the 1-16 in. hole in it, is screwed into the eyepiece tube—or a fairly high-power eyepiece with lenses removed may be used—to keep the eye central. On looking through this at the flat, the latter will appear circular; the end of the eyepiece tube will appear as a larger circle; and the two must be made exactly concentric, the six screws on the flat mounting being loosened and the brass rod supporting the flat moved until this is so. (Fig. 1.)

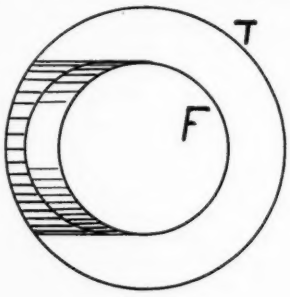

FIG. 1.

The center of the flat being placed exactly opposite the center of the e. p. tube, the reflection of the speculum will be seen as a circle somewhat smaller than the circle presented by the flat itself. The flat is now gently moved by means of the adjusting screws until the image of the mirror is exactly central in the flat. This is shown in Fig. 2, where F is the flat, M the speculum, and T the end of the e. p. tube.

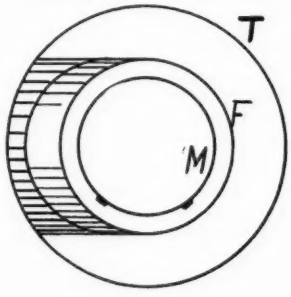

FIG. 2.

The adjustment of the speculum may now be considered. The eye being kept at the aperture in the brass cap, the flat will be seen as a very much smaller circle reflected in the speculum, as in Fig. 3, where it is shown out of adjustment. This small image has to be got exactly central with the other circles seen, and here a little method is of great assistance. If the screws at the back of the speculum are arranged as I advised in No. V, a good deal of time will be saved by always working as follows: The top screw is always turned by itself, turning it, or rather the nut, to the right; move the image of the flat downwards, in a direction at right angles to the axis of the tube. Turning to the left, of course has the opposite effect.

The two lower screws are always turned simultaneously, but in opposite directions. Turning them outward moves the image of the flat to the left, or up the tube and away from the speculum: turning them inwards moves the image to the right or down the tube. Thus in Fig. 3 the top screw would be turned to the right until the image k of the flat is level with the center of the circles k, and then the two lower screws would be turned inwards until the image is central, k. Some such rule as this will be found to save much time, as one is always certain what the effect of moving any screw will be; but if the screws push instead of pulling, as in my tube, the rule will be exactly reversed.

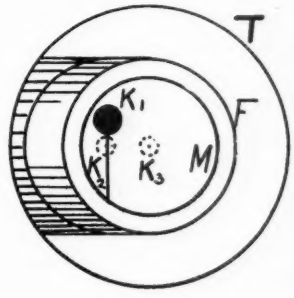

FIG. 3.

When all the circles are perfectly concentric, the mirrors are in adjustment, and any false light at one side of the image of the star will, if not due to the speculum, be due to the e. p. not being properly made, or the end of the e. p. tube not being cut off at right angles, or to the screw-thread by which the e. p. is held not being properly cut. To see where the fault lies, the e. p. tube may be rotated. If the fault is in the e. p., the wing, or irregularity of whatever sort, will also rotate round the image; but if it does not the fault lies in the speculum—less probably in the flat.

To adjust the finder, direct the telescope to a distant object or, though less conveniently, to the moon, and apply a low power. A little patience and care in moving the tube will soon get some object in the center of the field of view. The finder is then adjusted by means

of its supporting screws until the object in question comes on or, as I prefer, just above the intersection of the cross wires, these wires being placed so as to make an angle of 45° with the vertical. A higher power may be now applied, and the adjustment repeated; but even the preliminary adjustment will serve to get the Pole Star well into the field of the lowest power, and it can then be readily brought to the center and a higher power applied. As I said previously, it is well to use the eyepiece with which most work is likely to be done in the case of a 9 in., this will be 250 to 300. Once a star is in the centre of the field of view, the finder can be finally adjusted, and it must be remembered that finder must be readjusted every time the adjustments of the mirrors are altered in any way.

My own plan is to carry out the adjustment of the mirrors when required, which is seldom, by day, pointing the telescope to the sky; the finder is then adjusted by means of a house on a hill two miles off, and I am certain of being able to pick up a star with the lowest power; the final adjustment of the finder is then easy at the commencement of observations, the system I have adopted of mounting the finder greatly facilitating the work.

The appearance of a star in the telescope I have already described; but I may say a few more words on the subject. The image, when carefully focussed, should be a very minute, perfectly round disc, with one or two fine rings round it, and without any trace of wings or flare—except that when the mirror is silvered and a bright star observed, a faint band of light, due to the flat support, will be seen extending across the field of view in the direction of the axis of the telescope. This is a defraction effect and cannot be altogether avoided; but it is of very little importance, and practically not noticeable with any but bright stars, while, with planets, I have never seen it. In the ordinary way of supporting the flat, by three springs, six of these rays are produced.

If the flat justifies its name and really is a plane mirror, the image of a star should be perfectly round —that is, assuming the speculum to be a good surface of revolution—whatever its size may be. But, if the flat is defective, the disc of the star will be a cross in focus, and if the focus is very slightly disturbed one way or the other, it will become an ellipse, the major axis being directed either along or across the main tube. If the flat gives this appearance it should be rejected, as no critical definition can be looked for—and the defect is by no means uncommon. One flat I tried, though the work of a professional optician, was utterly defective in this way, and the telescope was quite useless until I obtained another, which at once removed all trace of the defect. This defect, of an oval disc, may be due to the speculum, as in the case of Dr. Common's first 5 ft. mirror, where it was due to some molecular stain in the glass of the speculum; but any such defect would be at once recognized in the testing at the center of the curvature.

It must be remembered that any and every night is not good enough for perfect definition; and it is only when the atmosphere is at rest and free from currents of irregularly heated air, that these very delicate tests can be applied; but if a good night can be got, the defects, if any, in the mirrors, will be obvious.

METHOD OF MAKING FINE WIRE.

A new method of forming very fine wires by an electrolytic treatment has been recently brought out at Paris by H. Abraham, a well-known physicist. The process consists in diminishing the section of a wire by using it as a soluble anode in an electrolytic cell. The resistance of the wire is taken at intervals and this gives an idea of the rate at which the section is diminished. The action is thus controlled and the current is cut off when the proper point has been reached. However, in order to obtain a regular section of the wire by this process, we must observe certain precautions. In the first place, the bath must be very dilute and have a high resistance so as to give a uniform distribution of current over all the length of the wire. This also allows some latitude in placing the two electrodes and they need not be given an exactly defined position. The best solution seems to be distilled water containing a few thousandths by weight of copper sulphate, or for silver wires, nitrate of silver can be used. Second, the operation should be carried out very slowly, so that the salt which forms around the wire will have time to diffuse in the bath. If this point is not observed the bath becomes conducting to great extent when the current is high and the wire is broken. The current density to be used here is on the order of 0.01 ampere per square centimeter surface of the wire. It is well to cut down the current density as the section of the wire diminishes. The experiment can be made very conveniently in a porcelain dish such as is used in photography. Here the wire can be seen readily. It is suspended by the ends from glass hooks and is soldered at the ends to two metal rods which lie outside the bath so as to avoid local circuits. "Electrical Review."

In the petrified forests of Arizona there are trunks of trees three to four feet in diameter and over 100 feet in length, entirely changed to quartz. According to Dana, the trees now silicified in Arizona appear originally to have flourished on the shores of an inland lake into which they fell and became water logged; then they were buried beneath volcanic material of a highly silicious character, which underwent alteration through the action of water, setting free more silica than the water could hold in solution. As this change took place only particle by particle, the minutest cells of the wood are preserved and may be seen through the microscope.

CASTING IN PLASTER MOLDS.

ALBERT T. SALT.

The fact that plaster of Paris is capable of reproducing the most minute design upon a pattern has caused it to be used for casting metals when the most exact impression of the pattern is desired. There is no substance known which will do this in the manner that plaster of Paris will do it.

The best results are obtained by the use of a mixture of asbestos and plaster of Paris. The asbestos acts in the same manner as the hair which is put into mortar and holds the plaster sufficiently to prevent its cracking when the hot metal strikes it. It will read ly be seen why asbestos is adapted to the work. Its fibrous nature acts admirably for holding the plaster together, and as there is no question about its ability to withstand the heat, asbestos is used with the accompanying good results.

It will readily be appreciated that the more plaster of Paris that can be used for making the mold the more delicate the impression will be. Hence it is desirable to use just as little asbestos as possible. Experience has shown that the lower the melting point of the metal which is to be cast the less quantity of asbestos that is required. For the very lowest melting metals very little or really none is required. For the very lowest melting metals very little or really none is required, although with the lead and antimony alloys a little asbestos mixed with the plaster gives more uniform results. For gold, silver, bronze or german-silver, the following proportions of asbestos and plaster of Paris should be used:

FOR GOLD, SILVER, BRONZE OR BRASS.	
Plaster of Paris	1 part.
Asbestos	1 part.
FOR GERMAN-SILVER OR OTHER NICKEL ALLOYS.	
Plaster of Paris	1 part.
Asbestos	2 parts.

The kind of asbestos to use is the short fiber and not the long, stringy kind that is used for packing, board or similar materials. This long fiber asbestos interferes with the impression as the fibers are apt to get between the pattern and the plaster. By the use of the short fiber, however, this difficulty is avoided and the impression is so nearly like that of the plaster alone that it can scarcely be distinguished. The proper kind of asbestos has an appearance similar to freshly fallen snow, while that of the long and unsuitable variety has an appearance of curled hair. These points should be borne in mind when an asbestos is selected for plaster casting. There is no difficulty in obtaining the right kind of asbestos from the manufacturer of asbestos goods. To say that short fiber asbestos is desired is usually all that is required. It should be ascertained, however, that the asbestos is free from sticks or other foreign matter, as these are apt to interfere with the impression of the pattern.

As for the plaster of Paris to use, it may be said that this occurs in commerce in two kinds: Ordinary plaster of Paris used for the manufacture of walls, stucco work, center pieces, or similar work, and dental plaster. This latter is excellent and is in a very finely divided condition and free from foreign matter, but is quite expensive when compared with the other kind. For ordinary work, however, the common grade of plaster of Paris is perfectly suitable and is that which is usually employed. It will be found that it is filled with lumps, sticks, paper, or other foreign matter, but these substances may be removed by riddling. When such a purification has been done, the plaster is excellent.

Let us take for an example of an article which is to be cast in plaster, a bronze medal which has been struck with great care from a steel die. In plaster every detail may be exactly reproduced so that, with a little trimming of " fins," one would actually believe that it had been struck with a die. It is necessary for the plaster molder to have the detail reproduced but it is possible for him to do so if he understands his business. It must be carefully borne in mind, however, that all the requirements of draught, gating, pouring, etc., which are necessary in sand casting are likewise necessary for casting in plaster. The method is practically the same, and unless a pattern will draw out of a sand mold it cannot be used for plaster. The same rule applies to pouring a gating, for the result is the same in either case. It will be taken for granted, therefore, that the reader of this article understands the art of sand molding. Unless he does it is feared that he will not be able to make a good job with plaster.

Taking for an example of plaster of Paris molding, the bronze die-struck medal, let us proceed to reproduce this in plaster. The first thing to do is to see that the medal is clean and free from dirt which would interfere with the molding. After this has been done, the surface is given a light coat of olive oil by means of a brush and tuft of cotton. This is done to prevent the plaster from adhering and to allow it to be removed after the plaster has set, without tearing taking place. A light film of oil is all that is required and too much will prevent an accurate impression from being taken.

For a bench, a marble slab is excellent, for the reason that it is flat, water does not rust or warp it, and the plaster may be easily removed from it. It is advisable to rub it over with a light coat of oil before beginning the work, as the plaster will then leave it

equally well as it will the pattern. Now place the medal upon the marble slab and place four pieces of wood around it in order to hold the plaster when it is poured in. These pieces of wood should be thick enough to stand by themselves.

The regular ¾-in. pine is perfectly suitable. The width of these pieces will depend upon the pattern and it should be sufficient to leave plenty of thickness of plaster outside of the pattern. If this is not done the mold is much more apt to crack. It is unnecessary to state that the edges of the pieces of wood should be straight and smooth, so that they will lie flat upon the marble slab and also adjoin one another with a tight joint. This is necessary on account of the semi-liquid nature of the plaster, which will tend to run out if the joints are not fairly tight. When all done, this arrangement is a simple box-like appliance for holding the plaster.

The wood strips are now held down by some lead weights or other suitable methods. The nowel, which this really is, is now ready for the plaster of Paris. The asbestos is mixed with water to the consistency of cream and kept in this form. It never becomes hard, so that it may be kept indefinitely in this form. If it is preserved in such a manner, the air gradually works out of it and there is less danger of bubbles forming upon the pattern where the plaster of Paris with which it is mixed, sets. How much plaster to use for the mold will have to be left to the judgment of the operator, and he will have to be sure that he has plenty. Like many other things, this part is a matter of experience, but is not at all difficult to learn.

For the mixing of the plaster and the asbestos with the necessary amount of water an enamelled kettle or pan is quite suitable. It does not rust like a tin pan. Fill it partly full of water and sift in the plaster of Paris until it just shows above the top of the water. Now add about one-half as much of the cream asbestos as there is of plaster mixture. This proportion is taken if it is desired to cast gold, silver, or bronze. If german-silver is to be cast, an equal amount of each is taken. After the asbestos has been added, the whole is stirred and the pan or kettle which contains it is brought near the mold.

Dip a medium stiff brush in the plaster mixture and "dab" the pattern all over so that all parts of the surface are covered with the plaster. This will ensure a perfect impression being made, and also free the pattern from air bubble. This will usually take from two to three minutes. When the plaster begins to set on the pattern, or medal, which we have used pour on the rest of the plaster mixture so that the wood frame used for the flask is filled to the top. Now wash out the pan before the mixture has set hard. If this is not done it will be difficult to remove it and a dirty pan will be had for the next operation.

As this setting is hardening, another flask may be prepared. This setting, however, usually takes place in a few minutes to a sufficient degree to allow the top to be scraped off with a steel scraper so that it is flat. This operation should be done when it is just barely set, as the plaster is then quite soft and the scraping is an easy operation. The weights may now be removed and, when the plaster has sufficiently set to allow it, the strips may be removed. If the strips of wood are varnished with shellac the removal is much facilitated and the plaster does not adhere as tightly as it does to the unvarnished wood.

Now turn the mold over so that the face side is up. This will bring the pattern, or medal, into view. If the plaster has run under it a little trimming, so as to leave the face uncovered will render everything in satisfactory shape. Now cut four conical holes in the corners of this mold so that when the cope has been cast, there will be four pins to serve as guides in closing the two parts. These will answer the same purpose as pins on a regular molders' flask. The conical holes may be made with a knife or any suitable tool. They should be deep enough to prevent any abrasion taking place when the mold is being closed. The depth, of course, depends upon the depth of the pattern, but any molder knows that a flask pin must be suited to the pattern, and so it is in this case.

Now soak this plaster mold in water until it will take up no more. This operation is necessary for the prevention of the other side or cope from adhering when it is set. Usually fifteen or twenty minutes are necessary for the complete soaking of this mold, and care should be taken that it is thoroughly soaked, otherwise the two halves will not pull apart as they should. While the soaking is going on, a third side may be prepared.

When the soaking is completed, the plaster mold is put back down upon the marble slab and wood strips placed around it as before. In this instance, however, the strips must be twice the width of those used before so as to allow the cope to be cast of the same thickness. As the strips which were used before were one and one-half inches in width, they must be three inches in this case. The surplus water should be removed from the pattern and, if necessary a little more oil rubbed in it. The pattern should not be removed at all until both sides have been cast and the mold parted.

The operation of mixing the plaster and asbestos is carried out in the same manner as before; but, in this instance, the operator can probably gauge the quantity which is required with more exactness than in the other case. The experience which has been gained with the other side will give an idea of how much to use. Dab the pattern with the brush as before and then, when the plaster which has been put on begins to set, pour on the remainder. It is usually advisable to let the plaster rise a little way above the wood strips, as it can then be shaved down to a flat surface with exactness. When this side has set sufficiently, the top may be scraped off as before. The whole mold

is now cast, and when set so that the mold will allow it, the strips may be removed and the mold allowed to set hard. Give it plenty of time to do this or difficulty will be experienced in getting the cope and nowel apart. Five or ten minutes will usually suffice for this and when it has been ascertained that the mold is hard enough to stand the opening operation, the halves may be pried apart by some hardwood wedges. These are inserted between the halves or at the joint. A table knife is also handy. The halves are simply pried open like a book.

If everything has been done properly, there will be produced a perfect mold and with the detail of the pattern exactly reproduced. It is better to cut the gate before the pattern has been removed, and this may be done in the same manner as in sand. Vents should be provided at the top of the casting, as there is no opportunity for the air to escape unless this is done. When the gate has been cut the pattern may be removed by means of a draw-nail or sharp pointed tool. Where to pry it out must be carefully considered, as a blemish will usually result where it is done. There are but few patterns, however, where there is not some spot which is better adapted for such a purpose than others, and this position should be used.

The backs of the cope and nowel may now be scraped so that they will be flat. This will allow an even pressure to be exerted when the halves are clamped together. The mold is now ready for drying. It will be seen that all of the water which the plaster has taken up must be driven off before the casting can take place. This is accomplished in an oven heated by gas. The heat which is best is one which is not extreme but gradual. The large excess of water should be driven off slowly and at the last a higher heat may be used. When all the water has been driven out of the mold, it will be found to be very light. As the plaster absorbs so much water, the drying is necessarily a slow operation, but it should not be hastened at all, otherwise the mold is liable to crack or blister. Take plenty of time if good results are desired. In drying, the mold should be set upon its face or back, as there is then more surface exposed for the drying and the mold is not apt to warp.

The mold, when dried, is ready for casting. The pins which have been cast on it serve to guide the cope into place, and when it has been done a hot iron plate is placed on the top and bottom and the mold clamped together. The plaster mold is also used when hot, as this insures the metal running in better shape and also obviates the absorption of moisture which a cold mold would be liable to do. The mold is now ready for casting and is usually poured on end as the castings, which are made in plaster molds, are generally thin and require the pressure of a gatehead to insure a sharp impression.

One of the requisites for successful plaster casting is the drying of the mold. As there is so much water in the mold, it dries very slowly and there is always a temptation to hasten it as much as possible. This should be avoided, as a mold which is dried quickly will warp and crack when it is being clamped.—"The Brass World."

The use of chemically treated carbons is increasing in many of the leading cities of Europe. In this case the carbons are either impregnated with a solution of certain salts, or they are cored and the salts in a solid form are placed in the inside of the carbon. The Bremer carbon is one of the most successful of these systems, and it gives a very brilliant and at the same time agreeable light which has a mellow hue and is not as trying to the eye as the ordinary arc light. In this case the carbon is treated with a fluoride of calcium solution. Besides the advantage as to the quality of the light, it is claimed that the Bremer carbon shows the highest efficiency has yet been obtained for an arc lamp, or 0.1 watt per candle-power. This form of lamp is generally used with a tight globe. It runs on ninety volts in some of the standard lamps. The light which it gives is of a yellowish color.

Steam is produced as follows: Water, although a continuous mass, is made up of a multitude of drops. Each drop of water is an elastic shell containing a certain amount of oxygen (air.) If one will take a clean kettle and place it on an ordinary fire he will notice that as soon as the water begins to get warm at the bottom little bubbles begin to form. This is caused by the expansion of the air in the water. The expansion continues until 212° Fahr. (boiling point) is reached, when the bubble bursts, the heated and expanded air passes through the water to the top, and in such passage picks up more or less of the water and becomes vaporous, when you get an expanded vapor caused by the passage of heated and expanded air through the water. In this state it has less friction than the air when expanded. In English we call it steam; the Frenchman says vapeur; the German says dampf, hot, moist air. We say a steam carriage, the German says ein dampf wagon.

New York City is about to try the experiment of making its own electric light. The high charges of private companies have had something to do with the new departure, and an interesting experiment in the use of city garbage as fuel has helped. It has been discovered that the street-cleaning department was paying to have material carried out to sea and dumped when that same material, burned under proper conditions, would furnish power for a large part, if not all of the city's public lighting. If this can be done on a large scale, material which has been a source of expense will become a means of considerable profit.

AN EASILY BUILT POWER LAUNCH.

By Courtesy of the Brooks Boat Mfg. Co.

II. Construction of Moulds and Frame.

Construction will begin with the keel. Mark out with pattern, marking lines across the keel at the places where the moulds come, being careful to get them exactly in place.

If the keel has been made in two pieces it is spliced by putting a butt block on the top side as shown in Fig. 2. This butt block is of oak of the same thickness and width of the keel, and about 12 in. long. It is fastened in place with sixteen $\frac{1}{2}$ in. tire or carriage bolts, $2\frac{1}{2}$ in. long; or the splice may be fastened with the same number of $1\frac{1}{2}$ in. screws.

The stem and stern keel are cut to shape from the patterns and the two parts are bolted together with carriage or tire bolts, as shown in Fig. 3. Before putting in these bolts, file the heads. Cut the rabbet in the stem $\frac{5}{8}$ in. deep, and make the outer edge of the stem $\frac{3}{4}$ in. thick. Fasten the stem-knee to the keel with two tire or carriage bolts, as shown in Fig. 3.

Cut the transom to shape from pattern and cut transom-knee out of oak $1\frac{3}{4}$ in. thick. Fasten the transom to the transom-knee with two bolts, and fasten the transom-knee with two bolts. Fasten the end of the keel to the transom with four $1\frac{1}{2}$ in. wire nails.

The moulds are temporary forms, used to get the shape of the boat; therefore any rough lumber may be used to make them, it being only necessary that their outer edge be exactly the shape of the patterns. The moulds may be made of 4 or 6 in. strips and fastened together as shown in Fig. 5, the corners being cut out to allow of the clamp and bilge stringer laying in so as to be flush with the outside of the mould. There are six moulds in this boat. The patterns only give half of each; that is, the pattern only gives one side of the mould, to the center-line, as shown in Fig. 9. You can, however, get all the measurements for the moulds from the patterns, and when the moulds are finished, you can prove them correct by trying the patterns on one side and then turn the pattern over and try it on the other side of each mould.

To set up the frame, set the keel on two horses, as shown in Fig. 1, letting the middle sag down five inches below the ends. Get this accurately by stretching a string over the keel from end to end of the keel and then springing down the keel until it measures 5 in. from the string to the keel, in the middle. Block the keel in this position. Set the moulds on their stations. Then fasten and brace the stem moulds and transom.

There is only one stop-water in this boat, located between the end of the keel and the stem, as shown in Fig. 3.

The clamps are sprung in place in the notches at the top of the moulds. The forward ends of the clamps are beveled and brought together against the back of the stem, as shown in Fig. 8. The two ends of the clamps are fastened together with three $1\frac{1}{4}$ in. No. 12 screws, two of them from one side and one from the other, as shown in Fig. 8. The ends of the clamps are fastened to the stem with two ten penny casing nails, slanted down through the clamps into the stem, as shown.

The after-end of the clamps end against the transom, where they are fastened to cleats. These are 2 in. wide and 1 in. thick, and are nailed to the inside of the transom, $1\frac{5}{8}$ in. from the outer edge as shown in Fig. 9. These cleats may be fastened to the transom with eight or ten $1\frac{1}{4}$ screws. The ends of the clamps are flush with the top of the transom, but are $\frac{3}{4}$ of an inch from the outer edge of it. This is so that, when the ribs are put in they will come flush with the edge of the transom. The clamps may be temporarily held in place at each mould with a small screw.

On account of the length of your material you will probably have to put each clamp in with two pieces. When this is done the splice is made by putting a butt block, 12 in. long and the same size of the clamp on the outside over the splice, fastening it to the clamp with $1\frac{1}{4}$ in. No. 12 screws.

The bilge-stringers fit into the bottom corners of the moulds, the same as they did into the clamps at the top. The forward end of the bilge stringers are beveled off and fastened to the side of the stem-knee with two $1\frac{1}{4}$ inch screws, as shown in Fig. 10.

The after end of the bilge stringers butt against the transom, and are fastened to the bottom of the cleat the same as the clamps, and when necessary they are spliced in the same way. The end of the bilge stringers come flush with the bottom of the transom, but are $\frac{3}{4}$ of an inch, or the thickness of the ribs, inside the outer edge of the transom.

The term ash in chemistry refers to the fixed residue obtained by burning any part of an organized substance in air. Ash usually contains the following metallic and non metallic elements: Potassium, sodium, calcium, barium, iron, manganese, aluminum, copper, zinc. Non-metals: Chlorine, bromine, iodine, phosphorus, sulphur, silicon, carbon.

"The more a man talks the less he has to say."

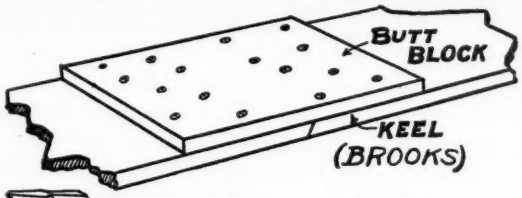

FIG. 2.

FIG. 5.

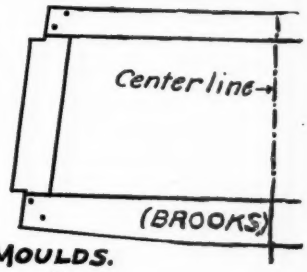

FIG. 6.

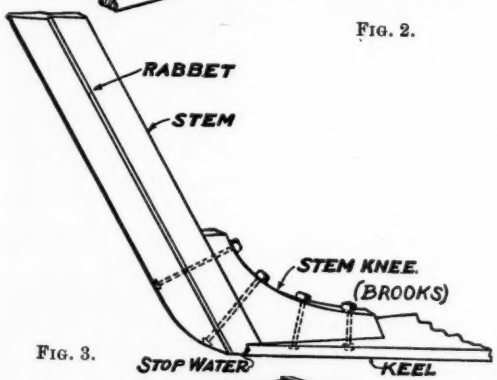

FIG. 3.

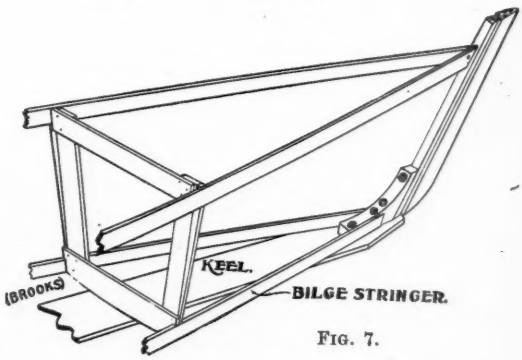

FIG. 7.

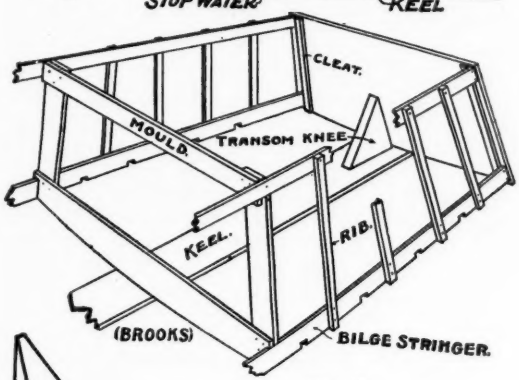

FIG. 4.

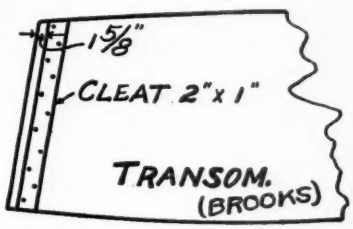

FIG. 9.

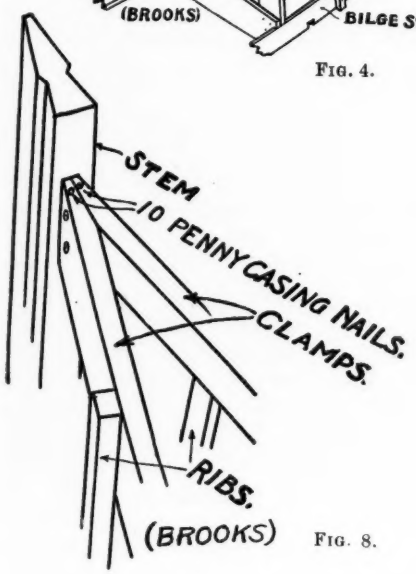

FIG. 8.

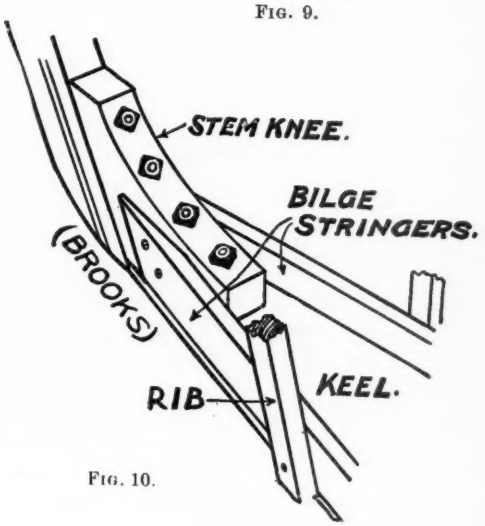

FIG. 10.

AMATEUR WORK.

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JANUARY, 1906.

The rapid increase in our subscription list during the past few months is very gratifying to the publishers of this magazine. The wide territory from which subscriptions have been received enables us to say that the "Sun never sets on AMATEUR WORK."

Australia, New Zealand, Philippines, Hawaii, Alaska, many countries in South America and Europe gives to our circulation an international character.

This may prove of decided value to tne "Society of Model Makers" when organized, enabling the members by correspondence to obtain information about work in all sections of the globe. As our readers undoubtedly have kindred interests, those contemplating a foreign trip will be given the names of subscribers in the countries they contemplate visiting, and we feel confident that acquaintances formed in this way will be pleasant and profitable to both visitor and visited.

The organizing of the "Society of Model Engineers" is progressing as rapidly as circumstances will permit, much correspondence being necessary in the drafting of the articles of incorporation, constitution and by-laws. We have received a large number of letters from readers expressing a desire on the part of the writers to become members, and we have no question of the very successful results which will follow when the Society is in active operation. Many writers have suggested that the Society procure designs and parts for model engines, tools, etc., and one of the first things to be taken up will be the offering of prizes for the best designs and descriptions for various models. Readers having any particular wants in this line, are invited to express them by letter, that those of greatest interest may receive first consideration.

The mention of the proposed "Society of Model Makers" has occasioned this question from a few readers—"Of what value is model making?" The answer has been the subject of a number of articles in this column, but its importance is great enough to warrant further attention.

The making and use of well designed and constructed working models, is probably the best possible method of learning the construction and operation of the machine of which they are a reproduction on a small scale, short of actual work upon those of full size. As circumstances prevent the great majority of readers from complying with the latter condition, the model alone remains as a subject for work and study, hence its great utility as a means of instruction, combined generally with the additional advantage of being the source of much enjoyment.

The practical side lies in the fact that knowledge acquired in this way may, at some future time be of the utmost value in fitting one to occupy a more responsible position in industrial life, but even if such direct benefits should not follow, many advantages not so evident are quite probable. The ability to grasp mechanical conditions may enable one to appreciate the merits or the faults of an invention or industrial enterprise to the end that a profitable venture is begun or an unprofitable one avoided.

The amateur mechanic or electrician of ability and experience is not the one who puts time or money into Keeley motors, non-refillable bottles, or gold-from-sea-water delusions, but, on the contrary, it is the class who have given no time to model making and study, and are consequently without the education to be derived therefrom who, because of that ignorance cannot discover the false note accompanying such enterprises, and rush into investments which can never prove profitable, and many times lose the savings of years.

A CORNER CUPBOARD.

CHARLES R. BLAISDELL.

Those of us bachelors, young or old, who are obliged to make one room serve the purposes of a suite, may find the corner cupboard here described of assistance in providing additional storage for wearing apparel of various kinds; hats on the shelf, clothing on the hooks and rubbers on the floor. It requires but little in the way of lumber, and if measurements are made before ordering all the sawing can be done at the lumber mill, leaving the work of putting together to consist of driving a few nails and screws.

It should not be higher than the picture moulding of a room, which in many houses is below the frieze of the wall paper. If this moulding is at the top of the wall, as it is in many houses of recent construction, the height may be about 7½ ft. The width will depend upon the size of the room and the space available, but most rooms have a corner allowing a cupboard at least 4 ft. wide or, more properly, front measure in this case.

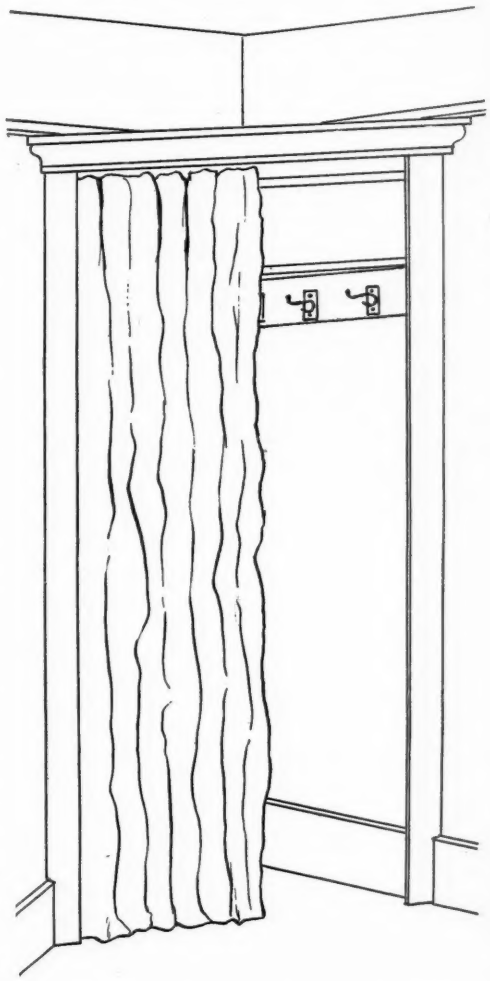
The wood used should be that like the room in which it is to be placed, or similar to it. Cypress can be used in a room finished in white wood, chestnut or ash, and is a good wood for the purpose. The necessary pieces are: A strip of moulding at the top; three pieces 3½ in. wide, one at each side and one at the back; two pieces 3 ft. long and 5 in. wide to support the shelves, and a piece 5 ft. long and 12 in. wide for the shelf. The latter piece is sawed into two pieces, the cut being at 45° angle, to give one piece 4 ft. long, the other 2 ft. long on the longest edges, the other ends being also cut off to the same angle.

The method of attaching the pieces permits of their being easily taken apart in case of a move, a matter not infrequent with those who board. The moulding is attached to the two side strips by 1½ in. screws, the heads being on the inside.

The two supports for the shelf are fastened together at the ends in the corner with two 3 in. angle irons and ½ in. screws. The outer ends are attached to the side pieces in the same way, after first bringing the angles to the increased angle at which these pieces meet. A block of wood can be screwed to the side pieces under the ends of the shelf supports to help carry the weight should it be thought desirable, although it will hardly be necessary.

It will be noted in the drawing that the lower ends of the side strips are cut out to fit over the baseboard of the room. These ends are also fastened by angle irons to the baseboard. If there should be any objection to putting screws into the baseboard, two strips 3 in. wide are run from the side strips and fastened the same as were those under the shelf.

The remaining long strip is now cut out to a halved joint and fastened with screws to one of the supports for the shelf, and the lower end to the baseboard or to one of the strips just mentioned. It will be necessary



to keep it all rigid by fastening with angle irons to the wall somewhere, preferably just above the shelves. The shelves are not fastened or at most, by two screws at each end. A curtain pole and portiere complete the outfit, after having put on the clothes hooks.

THE PROBLEM OF THE GAS TURBINE.

Abstracts from an address by A. Dougal Clark, Prest. of the Junior Institute of Engineers, London.

The wonderful success obtained by your distinguished Past-President, the Hon. C. A. Parsons, and his many able followers with the steam turbine in its various forms, has naturally attracted the attention of engineers to the apparently analogous problem of the internal combustion turbine. Accordingly, much mathematical and engineering ability has been recently devoted to the subject so far, I am sorry to say, without concrete result. In this subject, as yet, the dreams of the theorist obstinately decline to realize themselves in tangible iron and steel.

I have not been able to find any gas-turbine in a state of effective rotation doing useful work, though I have noted many statements in the Press to the effect that some wonderful German, French or Italian gas-turbine had worked, or was about to work in such manner as to relegate the ordinary cylinder and piston gas-engine to the museum with which many engineers used to threaten the steam-engine. One gas-turbine only has really rotated within my own direct knowledge. It was designed by Mr. F. W. Lanchester of Birmingham, to operate with exhaust gases from one of the petrol engines used in his well-known motor-cars. He assured me a few days ago that it really rotated at a high speed, and made a loud shrieking noise, but only gave, he said, a total brake horse power equal to that capable of being evolved by two blue-bottle flies. This power he did not consider satisfactory.

Speaking seriously, it does seem remarkable that so much interest should be taken by so many able men without any sort of result in practice. Why is this? I propose tonight to answer the question in so far as I can. It appears to me that most of those who have written on gas-turbines and have even designed and patented them, have given too little weight to certain differences between the steam and internal combustion engine problem. Many, indeed, have assumed that the solution of the gas-turbine problem is the easier of the two, and that few difficulties exist which have not already been met and conquered by Mr. Parsons in the steam turbine.

Many distinguished men have been of this opinion; and even Mr. Parsons himself, so early as his first turbine patent, appears to have been of the opinion that the hot gas or internal combustion turbine presented practically the same problem as the steam-turbine. In his specification Mr. Parsons clearly intended to apply his invention to the gas-turbine as well as the steam-turbine; and he outlined the fundamental idea of nearly all subsequent proposals of gas-turbines. Many other inventors have followed him; but I may only mention two well-known names—those of Ferranti and Stodola. Both have proposed turbines similar to his, with more or less elaboration, as well as other modifications intended to overcome certain difficulties.

In most of the recent discussions upon gas-turbine problems, it has been recognized that the temperatures possible to the cylinder gas-engine are impossible for the gas turbine. It has been fully proved by many investigators, including myself, that the temperature quite common in ordinary gas-engine practice ranges as high as 2000° C., though in the best practice, for most economical results, 1500° C., or 1600 C. appears to be an upper limit. With these temperatures a first-class modern gas-engine of about 40 h. p. will give an indicated efficiency of 35 per cent. At the same time the negative work of the cycle is so low tbat the mechanical efficiency of the engine may be as high as 86 per cent, or even more. If one realizes what the temperature of 2000° C. means, it becomes very evident that no turbine constructed either on the lines of Parsons or Laval could possibly be made to work with continuous supply of such gases; as 2000° C. is considerably above the melting-point of platinum. It is much higher than the temperature at which cast-iron flows from the blast furnace or, indeed, the temperature of the interior of the blast furnace. Any blades of iron, steel, or, in fact, of any other material, even fire-brick itself, becomes fluid or semi-fluid at the temperature. It is obviously hopeless, therefore, to attempt in the gas-turbine temperatures which are quite feasible in the cylinder-engine. This fact as I have said, is accordingly said, by those who take a favorable view of the gas-turbine, that it is necessary to supply the turbine with gases at a much lower temperature. Mr. Neilson fixes the temperature of 700° C. as one which steel turbine blades would probably stand without too rapid deterioration. I fear that on this point I must differ from him, because in my experience, oxidation of steel and even iron, is a fairly rapid process at this temperature. Nothing new has been proposed as to the thermo-dynamic cycle of the gas-turbine; so that all reasoning upon efficiencies depends upon the deductions already made from internal combustion engine practice.

Seeing the impossibility of consuming a turbine with materials to stand a high temperature, many have proposed to convert high temperature into kinetic energy, so that instead of having work stored up in the gas in the form of heat, the heat shall disappear and the energy of the heat be transformed into motion of the gaseous particles at a high velocity. Such proposals, then, include the compressing of a gaseous mixture to (say) 50 or 60 lbs. above atmosphere; the igniting of that mixture within a combustion chamber

at constant pressure; and the expansion of the mixture through an expanding jet of the Laval type so as to drop the temperature and obtain its equivalent in kinetic energy or velocity of the gaseous particles. The rapidly moving particles at the relatively low pressure and temperature are then allowed to impinge upon rapidly rotating blades of sickle co-figuration; and they are supposed to give up their energy of motion to the blades, and so expend work upon the turbine. This appears to be the most feasible of all the gas-turbine proposals, so I will proceed to examine it little more minutely.

Success by this cycle of operations requires (1) A rotary or turbine compressor of high relative efficiency. (2) An expanding nozzle which shall insure that free expansion is quantitatively equivalent to adiabatic expansion behind a piston. (3) A rotating turbine of such construction as to secure a very high efficiency of kinetic energy of the moving gas into effective work available at the turbine shaft.

Assuming air to be the working fluid, and the specific heat to be constant through the temperature range, it is easy to calculate the efficiency of the Joule or Brayton cycle, that these operations in effect represent. It would be useless to attempt to work a turbine at a pressure so low as to be relatively inefficient compared with the gas-engine, so I have chosen a Joule cycle of (say) 48 per cent ideal efficiency, which in a cylinder gas-engine would probably give in practice about 30 per cent, indicated efficiency. For the ideal efficiency the pressure of compression would require to be 141 lbs. per square inch absolute. To give power with a reasonably small pump, I shall assume a maximum temperature of 1700° C.—that is, assuming a perfect compressor and a perfect nozzle expander, the temperture would only fall from 1700° C. to 750 C. Plainly, this temperature would be too high for a Laval disc with blades. In order to get a reasonable temperature in the combustion chamber, no higher than 1000° C.; and this would bring down the temperature after complete expansion to about 500° C., which, no doubt, steel turbine blades can be expected to stand for some considerable time.

With these assumptions, however, the gas-turbine would not be very economical as compared with cylinder engines, even assuming all difficulties overcome. The theoretical and practical difficulties, however, are very serious indeed. To begin with the question of an efficient air-compressor, I am not aware of any turbine compressor capable of compressing up to 140 pounds, absolute from atmosphere from anything like 60 per cent. efficiency. Before success could be attained, this efficiency of compression, so far as the diagram is concerned, should be at least 90 per cent in order to allow for unavoidable mechanical and other losses in the subsequent processes. It has, it is true, been proposed to substitute cylinder compressors operated from the turbine, instead of turbine compressors; but this, it appears to me, would be equivalent to abandoning at once all the advantages of the turbine principle. If reciprocating cylinders are to be used for compressing, there is no objection to using them also for expanding. No gas turbine with cylinder compressors could, in my view, succeed.

Assuming, however, even 90 per cent efficiency from a turbine compressor, and assuming that we have a compressed gaseous mixture burning freely in the combustion chamber at the desired pressure and temperature, we have yet to face the problem of the expanding nozzle. It is always assumed that, with the use of an expanding nozzle, temperature drop can be as certainly attained as with an expanding piston in a cylinder. This, it seems to me, has by no means been proved.

You will all recollect Dr. Soule's famous experiment with two vessels immersed in water and connected together by a pipe having a stop-cock upon it. Air was compressed into one of the vessels, the water round the vessels stirred and equilibrium obtained, while the other vessel was rendered as vacuous as possible, and it was then found that, when the water was stirred again no disturbance of the equilibrium ensued. This, of course, meant that though heat was lost in the one vessel — giving velocity to the gases — it was gained in the other by the impact of the gases against the walls.

Joule modified this experiment by placing the two air-vessels in separate water containers. He then found that the temperature of the one dropped, due to expansion, but temperature of the other rose as much as the first dropped. Apply this experiment to reasoning on the behavior of the flame in an expanding nozzle. Assume the two vessels to be connected by a Laval nozzle, and assume that while in the nozzle the gases experienced the full temperature fall due to adiabatic expansion. Immediately, however, on contact with the walls of the second vessel, the velocity of the particles would be stopped, and the temperature would be restored to a point somewhat above the original temperature—that is, the mass of expanding flame in the pressure vessel would gain heat by the amount the first vessel lost. This is the result of the final process. It will be easily recognized that to obtain sufficient temperature drop in an expanding nozzle, necessitates the practical absence of turbulent motion of every kind—that is, to expand adiabetically, the jet must be so constructed that there is an absolutely smooth flow from high pressure to low, and no impact or loss of velocity from any cause whatever. So far as I understand expanding jets, no adiabatic expansion so perfect as this has ever been obtained.

Assume, however, that the efficiency of expansion in such a jet is (say) 90° per cent. We now come to the question of the efficiency of conversion by the turbine blades. In many calculations from diagrams, it is assumed that the efficiency of conversion of motion into work is practicaly perfect. This, however, is by no means the case in present turbines. Even the steam-

turbine, high as its efficiency is, compared with the reciprocating engine, has no very high efficiency of conversion in any of the forms of turbines that are at present on the market. That is, if we assume a mass of gas to exist in a compressed state in a reservoir, and we choose to expand this mass of gas in two ways—for the sake of comparison, (1) behind a piston, and (2) by means of a Laval jet and turbine—we shall find that the efficiency of conversion of the turbine, when once high velocity is attained, does not exceed 80 per cent. In this respect the efficiency of conversion of rotating turbine blades is inferior to that of a moving piston in a cylinder. The reason of this is obvious. It is impossible to so arrange the impact of a rapidly moving gas with a turbine blade or blades in such a manner as to entirely avoid any turbulent motion.

The impact, for example, of swiftly moving gases on a fixed surface ultimately results entirely in turbulent motion, which restores to the gas or to the blade struck all the heat which has disappeared in temperature fall due to adiabetic expansion. What is true of a fixed blade is to some extent also true of the moving turbine blades. A certain proportion of the energy existing in the gas in the form of motion is inevitably lost when this gas comes into contact with any solid surfaces. So much is this the fact, that in designing steam-turbine blades for any type of turbine, the shape of the blades, the shape of the space between the blades—both moving and fixed blades, or fixed jet and moving blades—is of the first importance; and it has only been found by experiment that certain shapes of blades and passages have a much higher efficiency of conversion than other shapes.

In this respect, too, the turbine principle is inferior to the cylinder and piston. In a cylinder, with gases expanding behind the piston, the efficiency of expansion may be considered to be 100 per cent, and even an efficiency of compression in many gas engines is also the same order. I do not here refer, of course, to heat losses due to conduction, or anything of that kind, but to efficiency of adiobatic compression or expansion.

Although the efficiency of expansion is relatively low for gases in steam-turbines, yet the turbine offers a great advantage in total work obtained from steam. This is due to the fact that the turbine avoids initial condensation; and, further, it permits of the utilization of a very long range of expansion at the low-pressure end, which is not available in the case of steam-engines. By saving, therefore, in minimizing initial condensation, and in obtaining added work from pressures wasted in the ordinary steam-engine, the Parsons steam-turbine more than compensates for any inefficiency of expansion as compared with the cylinder engine.

It is well known, however, in turbines of practically all constructions, including that of Mr. Parsons, that the efficiency of the steam-turbines is not so great as that at the low-pressure end. This is partly due to the difficulty of adjusting the velocity of the blades to suit the necessarily varying velocities at different points of the flow of the steam. This, however, is a small difficulty with the steam-turbine, but a very considerable one with the gas-turbine. Compared with cylinder expansion, I cannot see how it is possible with present knowledge to obtain an efficiency of conversion in a gas-turbine greater than 80 per cent. This is partly due to the high velocity of the issuing hot gases.

To produce an efficient gas-turbine, therefore, on the favorite cycle so much discussed recently, it is necessary first to have, as I have said, a very efficient compressor, a very efficient conversion when the moving gases strike the turbine blades. Using the numbers I have suggested, of 90 per cent efficiency of nozzle expansion, and 80 per cent efficiency of conversion in the turbine, we have a cycle having negative work equal to 0.4 of work in compression, we shall require 0.445 of work put into the compression. On expanding in the nozzle, we shall obtain 0.9 only of the total energy of flame gates in the shape of kinetic energy; and of that 0.9 we shall only get 0.8 returned in the shape of available work by the turbine part. That is, we shall get a total work from the turbine of 0.72; and deducting the negative work, $0.72-0.445=0.275$. That is, from a cycle which should give us 0.6 in work, we shall only get 0.275 or about 22 per cent.

The practical efficiency of an engine of this kind will only be 22 per cent, even assuming the high efficiencies of compression and jet expansion which I have mentioned. In my view, no such efficiencies of compression or jet expansion are at present known; and accordingly there appears no likelihood of the production of any gas-turbine which can rival the reciprocating gas-engine in efficiency and in economy. To produce such a turbine requires the solution of three problems: (1) An efficient turbine compressor, comparable in efficiency with cylinder compression. (2) An efficient nozzle expander with a higher efficiency than 90 per cent. (3) An efficiency of conversion of kinetic energy of the moving gases into work delivered at the turbine spindle of greater than 80 per cent. Either these problems must be satisfactorily solved, or else new materials discovered which will stand temperatures which at present melt firebrick. The outlook, I fear is not hopeful.

From what I have said, you will see that my view of the future of the gas-turbine is not favorable. But, notwithstanding, the subject is so fascinating that many inventors and scientific men will doubtless continue to investigate the problem; and possibly new solutions may be discovered which are not dreamed of today. I am the last man in the world to deprecate daring in any practical and scientific work; but I would advise the junior engineers—members of our Institution—to avoid the subject, except as a scientific study. I fear there is little hope for a young man to make a position and a business success of any internal combustion turbine, so far as present knowledge carries us.

PHOTOGRAPHY.

WATERTONE SEPIA PRINTING PAPER.

JAMES THOMPSON.

Sepia watertone papers, simple to work and cheap withal, are not a novelty, and to some it may seem superflous for me to instruct the amateur worker as to a manner in which he may prepare such a printing media for himself. The papers on the market are, it must be confessed, most convenient for the multitude, coming, as such do, all nicely coated and cut to convenient sizes.

Some individuals there be too indolent to do anything for themselves, and from such the dealer will always reap a harvest, high cost being no bar to the customer's purchasing. Some there are are, on the other hand, who buy the good thing only when it is cheap, and to such the sepia watertone paper will appeal, for it is both good and reasonable in price; but in addition to the people enumerated there are many workers desirous of results removed from the common, and by sensitizing their own printing media, these individuals can be suited as regards quality and texture. Many are thus found printing pictures on specially selected papers, leaving around the image, printed space, a generous margin, which imparts to their work much of the charm pertaining to the etching or engraving. In some notable examples the result has much of the refinement and quiet elegance of the wash drawing, looking anything but photographic.

For those who sigh for such effects, and to meet the demands of those who aspire to print on note paper, postal cards, menu cards and textile fabrics, such as cotton, linen, silk and the like, as well as parchment and various suitable brands of leather, I submit a formula giving fine sepia tones and requiring nothing more than plain water for development and weak hypo as a fixative. In fact, the manipulation is precisely the same as that advised for the Eastman sepia paper, and barring the hypo, is the identical procedure essential in the production of the blue print.

A rather close grained paper is in order, for when porous the elimination of the unreduced salts is difficult, even with a prolonged washing. Where "velvety" effects are desired, a generous application of size is imperative, and where keeping qualities are in view, linen paper must be employed. With the cheaper wood pulp stock one must in time expect deterioration, and the development of that sickly yellowness so noticeable in the cheap book.

Do not begrudge the price. The best paper is essential; high class bond or ledger stock, for example, being admirable for the purpose, providing there is a generous application of size to give softness to the image. Arrowroot size is among the best and may be prepared in the proportion of two grains of the powder to the ounce of water. Beat up with a little cold water in a bowl, adding balance of water hot. Bring to a boil, when the cloudiness will disappear and the size be ready for use. During the past few years I have worked out more than a dozen sepia formulas. Some are slightly better than others, and among the best is the one I am about to submit.

SALTING SOLUTION.

Citrate of Iron and Ammonia	40	Grs.
Ferric Oxalate Merck's	15	"
Oxalic Acid	15	"
Oxalate of Potassium	30	"
Citric Acid	5	"
Gum Arabic	10	"
Distilled Water	1½	Oz.

Mix in order given in a dark bottle, letting stand at least 12 hours before using. Apply with a flexible pad or wad of absorbent cotton, drying by the fire so as to keep the solution on the surface. When thoroughly dry coat with the silver solution, which should be prepared as follows:

SILVER SOLUTION.

Nitrate of Silver	55	Grs.
Citric Acid	25	"
Distilled Water	1	Oz.

When the chemicals are dissolved, this will be ready for use, and like the salting solution it should be protected from light by keeping in a cool, dark place.

Coat with the silver solution and immediately dry by artificial heat. The best and most vigorous prints result from a thin, even coating of the salting solution, for when the latter is in excess the image is apt to have a muddy, bronzed appearance. The best results I have had by using rather small sheets of paper and applying the solution quickly with a wad of absorbent cotton, drying immediately by the fire. This procedure is most essential when the rough surface or more porous papers are used. When the paper is hard and smooth one may get better results by allowing the surface to become nearly dry before hastening with artificial heat.

Under print rather than over. Half tones should not be visible at all. Wash away the unaffected salts in clear water, from one to three minutes being sufficient. Then transfer to the cleaning bath, one and a half grains of common salt and hypo to each oz. of water used. In this the print will rapidly darken, and

in from 1 to 3 minutes, or when at its best, remove and wash for 20 or 30 minutes.

When the printing has been deep, longer fixing can do no harm, provided there is no bleaching of the half tones. Long fixing alters the color, usually having a darkening effect, and my own preference is for the colors obtained by short fixing as being more satisfactory in tone.

The formula here submitted is about right for the average pictorial negative, one rather thin but full of detail and fine gradation. For dense negatives a dilution of solution containing the iron will be necessary, while on the other hand strong, vigorous prints may be obtained from these negatives by using but an ounce of water, instead of an ounce and a quarter, as per formula. If still more contrast is required, add from four to eight drops of a five per cent solution of bichromate of potassium.

I would remark that success of the process demands the keeping of solution on the surface of the paper, for when too much sunk into the meshes the results are apt to be poor. This is more than likely to be the case when soft papers are used, therefore the importance of rapid drying. Experience can alone determine best conditions and quality of paper to employ, but for the novice the ledger paper or bond stock may be with confidence recommended, where the surface is slightly spontaneously dried, and is then completed by artificial heat.

It is a most pleasing variation where the solutions are with a wad of cotton applied with studied carelessness to the spot where the image is to be. In such a procedure, when the sun has done its work we have a picture that has all the appearance of hand-brush work in sepia water color. This is more likely to be the case where the outlines are not too abrupt, and experience can alone determine how this can best be effected.

As before mentioned, printing of this character can be done on postal cards, note paper, envelopes, menu cards, etc., the results depending greatly on the quality of the paper used, as well as the sizing on same. Pure linen paper and arrowroot size will produce the most satisfactory results, but where pictures are for temporary purposes, or when simply experimenting, cheaper papers, such as may be obtained from the stationers all the way from 20 cents a pound will answer well enough.

Concerning postal cards, there is small use in attempting to print pictures on those issued by the government, the paper they are made from being so deplorably bad. Where postals made from good stock cannot be obtained at the stationers, pictures may be printed on good paper and the regular postal card employed on which to mount them, the entire writing surface of the card being covered. By passing a hot iron over the card perfect adhesion and flatness will be assured.

Where printing on cloth is attempted it will be best to wash out the stiffness, as the size that gives body to so many textile fabrics contains chemicals that will impair the photographic image. Size well with a good solution of arrowroot or in lieu of that, plain starch. Sensitize and paste on a stiff piece of paper cut to the dimensions of your printing frame. In this way there will be no difficulty in keeping in register when examining from time to time to note progress of printing.

With the formula here exploited a few minutes in the sun will be sufficient with ordinary negatives, the printing capacity of the process being quite rapid. On this account it will be well with more than usually thin negatives to print under one or more sheets of tissue. It is good a plan to follow at all times when printing in direct sunlight, the image thus being more likely to be permanent and always sharper and more decided regardless of other benefits.

Doubtless it may occur to some that if the two solutions were combined in one, the process would be ever so much simplified. Well, it is possible to combine the sensitizer with the salting solutisn, making good pictures thereby, but the results are not quite identical. Separate, the solutions keep better, and in my opinion the results are more uniform. Where the two are combined there is a heavy sediment so each time the coating is attempted the solution must be well shaken to thoroughly insure mixing of ingredients. However, for the benefit of labor savers, I submit a formula that will do the business in one application, and do it reasonably well.

SENSITIZER NO. 2.

Citrate of Iron and Ammonia	20	Grs.
Ferric Oxalate	18	"
Oxalate of Potassium	20	"
Gum Arabic	10	"
Silver Nitrate	50	"
Citric Acid	25	"
Distilled Water	1	Oz.

Mix the silver and citric acid in half of the water and the balance of ingredients in the remainder, combining the two after dissolving and shaking thoroughly. If found to be too strong, giving excessive contrasts, dilute with water, and when mixing a new lot, reduce the quantity of citrate and oxalate of iron, say two grains of each. It should always be borne in mind that prints dry out much darker than appearances while in the wash water would indicate. The following is suggested for strong negatives:

SENSITIZER FOR STRONG NEGATITES.

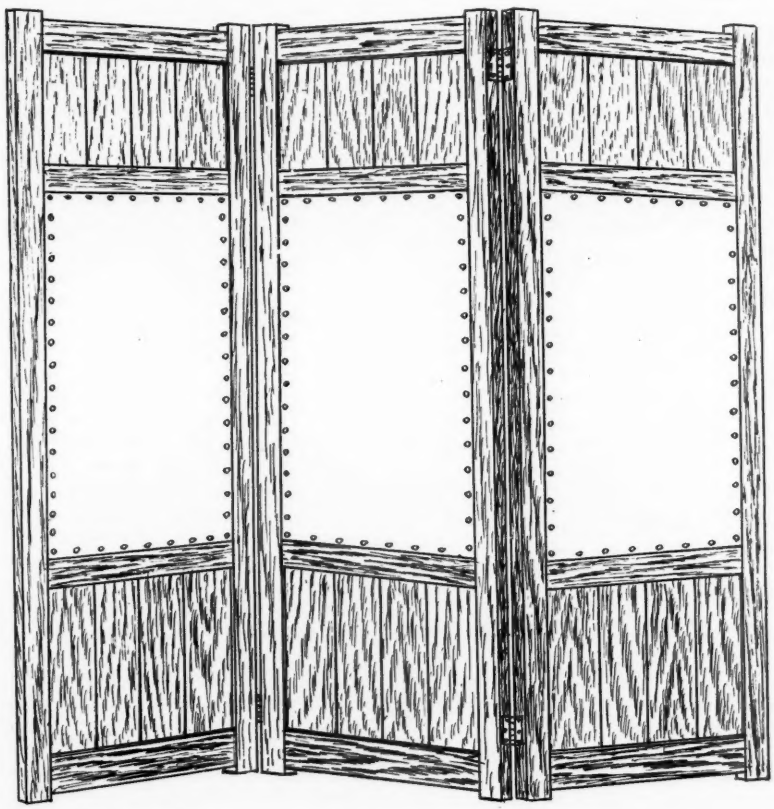
Citrate of IronAmmonia	17	Grs.
Ferric Oxalate	17	"
Oxalate of Potassium	18	"
Gum Arabic	10	"
Silver Nitrate	50	"
Citric Acid	23	"
Water (Distilled)	1	Oz.

The pictures from these formulas are of a warm sepia, without a trace of fog, and all detail in the negative should appear in the print even in the highest lights—"Western Camera Notes."

A SUBSTANTIAL SCREEN.

JOHN F. ADAMS.

Now is the season of drafts made manifest by sundry colds, unless measures are taken to guard against them by means of screens; the one here described being quite attractive and yet not difficult to make by any one of ordinary skill with woodworking tools. As



will be noted from the illustration, there are panels of wood at both top and bottom of each section, the center covered with leather, real or imitation, cloth, cretonne or burlap, or ornamental wall paper laid on cloth. Exposed nails with large heads are used only when they would be in harmony with the covering.

The materials required for construction include:—Six pieces 6 ft. long, 2½ in. wide and 1¼ in. thick; six pieces 20 in. long, 2½ in. wide and 1¼ in. thick; six pieces 18 in. long, 2 in. wide and 1¼ in. thick, 30 ft. of stock 4½ in. wide and either ⅜ or ½ in. thick, the thinner wood being desirable because of less weight. Also 25 ft. of 1 x 1 in. strips for making the frame upon which to tack the coverings to the center panels. It is quite probable that the stock for the wood panels will have to be got out special if the width mentioned is used, but by using stock 3 in. wide, and having five strips in each panel, matched stock ½ in. thick can be used and this is a dimension commonly carried by dealers in interior finish.

If matched stock is not to be had, use strips ⅝ in. thick, and before gluing up bevel each edge slightly with a plane to form shallow V shaped channels at each joint. Use care not to have them very deep as but little surface for gluing is to be had at most. The upper panels measure 13 in. high and 18 in. wide; the lower ones are 16 in. high. The pieces surrounding the panels are all grooved to a depth of a trifle over ¼ in. the width of groove depending on the thickness of the panels.

The upper and lower cross pieces, 20 in. long, have

tenons 1½ in. long on each end, the edges being ⅝ in. from the ends of the side pieces. The cross pieces under the upper and above the lower panels have tenons ½ in. long and of width to fit the grooves for the panels, the grooves being cut long enough to allow for same. They are spaced 12 and 15 in. respectively from upper and lower cross pieces, making the height of the center panels 32½ in. The inner cross pieces are glued to side pieces only; the others are both glued and pinned with 3-16 in. dowel pins.

The 1-in. strips are glued to the inner edges of the center panel, allowing ½ in . on either edge, provided the covering is put on with large headed nails. If burlap or other cloth is used without nails, a frame is made of the strips, with a center piece to prevent bending and the cloth is tacked to the outer edges with upholstery tacks, the size of the frame being such as to allow a tight fit after the cloth is on. It is held in position with 1½ in. wire nails of small gauge and small heads, holes being bored with an awl put through both cloth and the strips, and the cloth smoothed over the holes, thus concealing the nails.

The sections are hinged together with iron hinges, or green bronzed ones, if a green stain is used on the wood. The most suitable woods to use are: Oak, if stained to match the other furniture of the rooms in which it is to be used, or red gum-wood with mahogany stain or mahogany with natural or dark finish. White wood can be used, but as much of the attractiveness of the screen depends upon the markings of the grain of the wood, this wood is not very suitable. A novel and extremely artistic combination is bird's-eye maple and a gray stain with wax finish, but this cannot be used unless the room is decorated in a style to harmonise.

ARTIFICIAL DIAMOODS.

Consul-General Guenther of Frankfort, writes concerning the most recent efforts for the production of artificial diamonds, as follows:

Crystallized carbon, as chemistry has taught for a long time, occurs in nature in two entirely different forms—as diamond and as graphite. Anyone who can afford to do so can burn a diamond in oxygen and become convinced that nothing remains except pure carbonic acid. The only compensation, except this knowledge, for the costliness of the experiment is the brilliant light colors under which the diamond, so to speak, gives up its life.

When the nature of the diamond was first discovered many chemists were full of hope that they would succeed in producing artificial diamonds of considerable size from carbon. This, however, has not been accomplished thus far, and today it is assumed that the formation of large diamonds, principally found in South Africa has been under conditions which have not been possible to produce in the laboratory. From time to time artificial diamonds have been made from carbon under great pressure, but these experiments were always more expensive than the value of the diamonds obtained and, besides, were very dangerous. In one instance the laboratory of the experimenter was completely destroyed.

The French chemist, Moissau, has shown a new method for producing artificial diamonds by the employment of molten iron as a solvent for carbon, and using the electric stove, invented by himself, for producing a degree of heat hitherto not reached. Through the intense heat of this electric stove and by sudden cooling of the molten metal, the carbon is separated in the form of very small diamond crystals. The London "Lancet" reports a further step in advance in the production of crystalized carbon through experiments of Dr. Burton of Cambridge. This scientist has proved that the diamond is a denser form of crystal than graphite, and that a lesser pressure is sufficient for producing artificial diamonds than had been employed heretofore. Doctor Burton in his experiments used a molten alloy of lead and some metallic calcium, which can also hold a small quantity of carbon in solution.

If the calcium is separated from the molten mass, some of the carbon crystallizes. The separation of calcium can, for instance, be accomplished through steam. If the introduction of steam is made during full red heat, then small graphite crystals are found in the resulting crust of lime; if the steam is introduced during a low red heat, no graphite is formed, but a number of microscopical crystals are formed, the properties of which are entirely identical with those of natural diamonds. These experiments, which may be continued, strengthen the belief that it may be possible some day to produce in the laboratory of the chemist diamonds of sufficient size and perfection to compete with natural diamonds.

These experiments furnish a new theory with reference to the probable origin of the diamonds, which may not have been under an excessively high temperature, but from a poculiar crystallization from a yet unknown solvent, perhaps under high pressure. The artificial diamonds obtained by Dr. Burton are pronounced to be the finest so far observed, because they possess an unusually high power of refraction.

Sir William Brookes, in a lecture recently delivered at Kimberley before the British Association, called attention to a peculiarity of diamonds, namely, that they are especially transparent for X-rays, while imitation diamonds hardly let these rays pass through them, and he declared that this furnished an excellent means of distinguishing genuine diamonds from imitation diamonds.

"It is an easy thing to criticise; in fact, any fool may criticise, but it takes a wise man to tell one how to make it better."

A VILLIAGE TELEPHONE EXCHANGE.

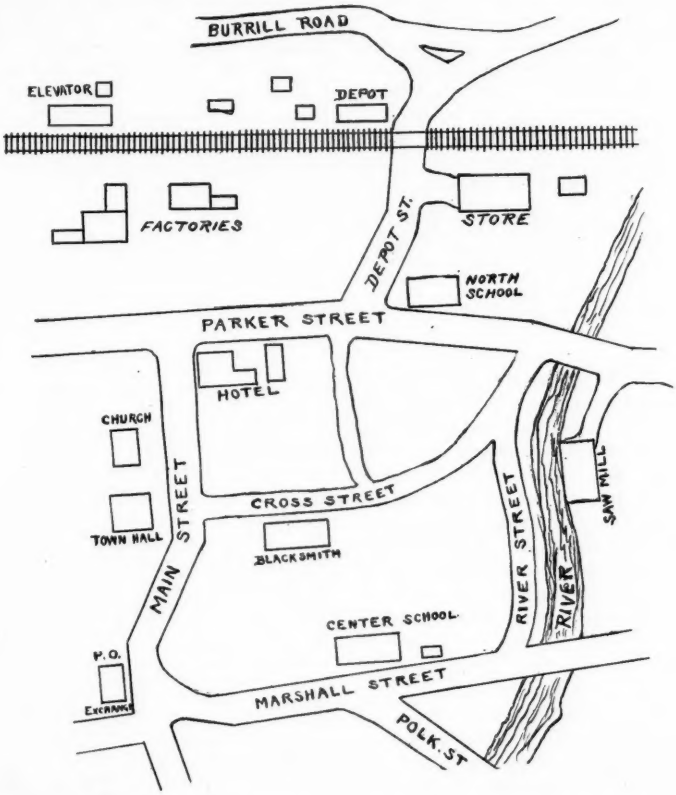
LAWRENCE V. STEVENS.

I. General Prospectus of the Exchange.

In previous numbers of this magazine have appeared details of telephone instrument construction calculated to give the amateur a clear and concise idea of the apparatus and theories upon which they operate.

It is now the intention of the writer to enter the domain of exchange construction, treating of the mutual exchange in which telephone service in established between 25 or 30 residences, stores and factories of a small agricultural or manufacturing community, the lines centralizing in a manually operated switch board located at the general store of the community.

There are three phases of this telephone proposition, namely the financial, the constructive and the maintaining problems, and of each the writer is disposed to treat in a connected series of articles dealing with each phase in proper order. Throughout the country, especially in the Middle and Southern States, this exchange proposition furnishes an exceptional opportunity for an active association of local capital and labor, the plant being self-sustaining from the start with favorable prospects of regular dividends after the first year of service.



It is to be understood that this exchange proposition deals entirely with one community and not with the general network of toll and long distance lines covering the territory. In years to come, connections may be made with other towns and other companies, a fixed charge being made for "trunking" between exchanges, but this feature is a matter which will adjust itself with the development of the plant and requires no consideration at this time.

An ideal way to describe the establishment of this

exchange is to enter at once upon the proposition in an imaginary community of 200 residents, where the inhabitants are enterprising and willing to co-operate in furthering the interests of a local enterprise.

Jefferson is the township's name and the location is in a State of the Middle West. The principal pursuit is farming; that is, poultry raising and fruit growing, although there are several general stores, a blacksmith and carriagesmith and two new factories near the railroad devoted to manufacture of woodenware and hardware specialties, also an elevator and hotel.

There are no large cities near Jefferson, and the town itself covers an expansive area. The annual increase in population averages 40. An outline map of the township is here given for future reference during construction, and it will be seen that many the houses are quite far apart and it may be presumed that isolation is quite complete in the winter time. The stores seem to be centered in the heart of each settlement, and the Post Office is kept in the largest general store at the Centre.

Into this community come the canvassers of the large and rival telephone companies of the West, but their propositions met with little favor from the inhabitants, principally because of the high rates quoted and also because the town, being self-sustaining, has but little use for telephone connection with such outer points.

The Jefferson Telephone Company, as a new home industry, possess a field of its own. It purposes to furnish day service between the hours of 7 A. M. and 8.30 P. M. at a rate of $1.50 per month for unlimited number of calls, 5 cents a call for subscribers listed under the limited rate, a charge of 10 cents per call for a message taken over the wire at the central office and delivered by messenger to a non-subscriber, and 15 cents a call for messages sent from the central office to pay station to any subscriber of the exchange. It is to be expected that most of the subscribers will take the unlimited service, thereby dispensing with charge accounts and considerable bookkeeping, but it will be found that there are citizens who want the service, but would not use more than a dozen calls per month, so to provide for this class of customers, accounts are to be kept at the special rate of 5 cents per call.

In the contract which the company makes with the citizens, all apparatus for the first 25 stations is to be purchased by joint and equal contributions by the subscribers, said apparatus to be furnished to future subscribers at a retail price; which, of course, is an inducement to get connected while the construction proceedings are under way. The company retains the sole right to provide the instruments to be used upon its lines; a very wise move at the outset, because uniformity in apparatus means successful transmission and a minimum of complaints.

Criticism may be made of the policy of charging a low rate for service and also charging for the instruments, when in some communities there is a fixed sum for the yearly rental or quarterly rental as the case may be, and the apparatus furnished free. It has been found that a monthly rental is more practicable than a quarterly, because the charge of $1.50 per month is more easily collected, and in case a delinquent subscriber does not settle within a month the service may be cut off at the pole without unpleasant argument at the subscriber's house, the wiring instruments remaining on the subscriber's premises as a silent reminder of the unpaid debt and a strong continual and unfailing argument in favor of re-establishment of the service. It will be found that once installed, the telephone will never be ordered disconnected except for a good cause, such as poor service, and under proper management there will be no poor service.

To this end, while the Jefferson Telephone Company depends entirely upon the good will and financial assistance of the first 25 subscribers, it will be found advisable to choose one of the number to manage the enterprise, and that the manager be given full power to manage and maintain the affairs of the company absolutely during his term of office, the other 24 subscibers keeping entirely aloof from all controversies and disagreements arising between the company and the public.

In the next article will be described the central exchange, the personnel of the first 25 subscribers and the arrangements for new business, with a general statement of first costs of equipment.

MARKING STEEL TOOLS.

Marking steel tools is sometimes done by an etching process, carried out as follows: A rubber stamp making white letters on a black ground is required. Then an ink to use with this stamp is made with resin, ½ lb.; lard oil, 1 tablespoonful; lampblack, 2 tablespoonfuls; turpentine, 2 tablespoonfuls. Melt the resin and stir in the other ingredients in the order given. When the ink is cold it should be like the ordinary printer's ink. Spread a little of the ink over the pad, ink the rubber stamp as usual, and press it on the clean steel—on a saw blade, for instance. With a strip of soft putty make a border round the stamped design as close up to the lettering as possible, so that no portion of the steel inside the ring of putty is exposed except the lettering. Pour the etching mixture into the putty ring composed of 1 oz. of nitric acid, 1 oz. of muriatic acid, and 12 oz. of water. Allow it to rest for only a minute, draw off the acid with a glass or rubber syringe and soak up the last trace of acid with a moist sponge. Take off the putty and wipe off the design with potash solution first, and then with turpentine.

The new premium list contains many new and useful tools. Send a postal for it.

A BAROMETER IN THE HOME.

H. M. CHADWICK.

The barometer, always an ornamental instrument, is easily discovered to be interesting and instructive also, if one takes the readings and records them rightly.

This can be done by means of the accompanying chart, which is arranged to cover a period of one week. The writer takes two readings daily, one in the morning just before starting for work, and one in the evening upon his return. This method is tolerably satisfactory, although of course one at midnight would give completer record.

The chart should be drawn to a full size scale in black ink on transparent paper or tracing-cloth; it should then then be put into a printing-frame with an unexposed negative, and printed onto the negative by exposure to lamplight. Care must be taken to get a negative and not a positive image on the plate. To do this place the face or ink side of the paper against the film. Develop the plate in the ordinary way, and print as many copies of the chart on blue print paper as may be desired.

The holder for the chart is made as shown in the cut and is to be fastened to the wall beside the barometer. The top moulding is removable to permit the changing of the charts each week.

Although the barometer is an instrument for recording the atmospheric pressure, its office is often misunderstood. Many people, seeing the words rain, change, fair, and so forth, on the dial, think that it is primarily a weather prophet. It does incidentally prophesy the weather, however, and the following rules are subscribed as being generally applicable:

"Generally the rising of the mercury indicates the approach of fair weather; the falling of it shows the approach of foul weather. In sultry weather the fall of the mercury indicates coming thunder. In winter the rise of the mercury indicates thaw, and its fall indicates snow. Whatever change of the weather suddenly follows a change in the barometer may be expected to last but a short time. Thus, if fair weather follow immediately the rise of the mercury, there will be very little of it; and in the same way, if foul weather follow the fall of the mercury it will last but a short time.

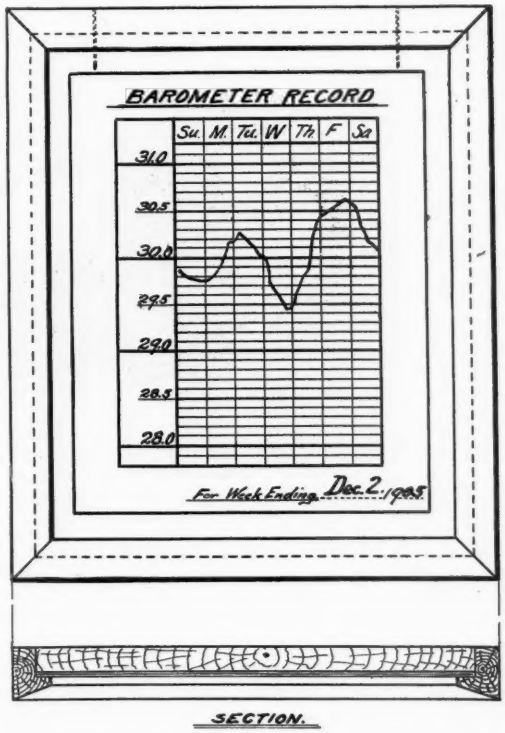
If fair weather continues for several days, during which the mercury continually falls, a long succession of foul weather will probably ensue; if foul weather continues for several days, while the mercury continually rises, a long succession of fair weather will probably succeed.

A fluctuating and unsettled state of the mercurial column indicates changeable weather."

These rules were given to the public in a lecture by Professor Lardner in 1846, and in his opinion they should be printed and sold with every barometer.

Prof. Lardner says: "It would be right, however, to express the rules only with that degree of probability which observation of past phenomena has justified. There is no rule respecting these effects which will hold good with perfect certainty in every case."

The terms rain, change, etc., are very misleading, as with a change of altitude the mercury assumes a different height, or in the aneroid, the hand moves along the scale without regard to the weather conditions.

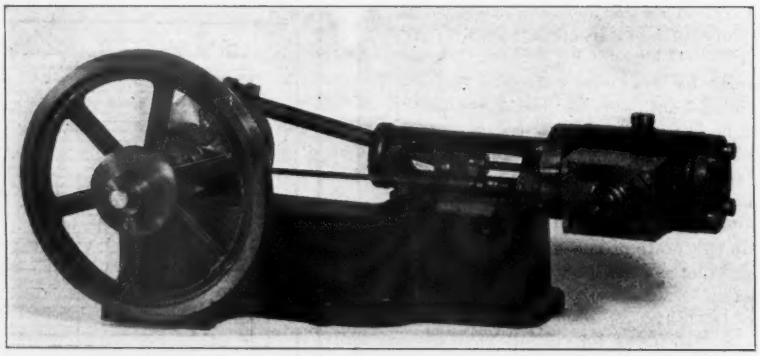


SECTION.

An instrument which is often called a barometer but which, properly speaking, is not, is the "little old man and little old woman" so common on our mantle shelves. This taking invention is really a hygrometer, since it indicates the degree of moisture in the air, and nothing else. The old man is popularly supposed to come out in stormy weather, and the old lady to appear with the sun; but on fine days with a humid atmosphere, the man is always out. The couple are interesting to watch, especially when they are observed in connection with the barometer. They should be placed out of doors in a sheltered spot where they may be seen from within, as under a porch near a window. This open air exposure is necessary, in winter at least, for the hot, dry air that comes from the furnaces of most of our dwellings causes the old lady to remain out for weeks at a time, if kept indoors.

MODEL STEAM ENGINE.

The illustration shows a model horizontal steam engine, obtained in England by Mr. F. S. Parsell of New York, together with several others, one of which has already been described in these columns. It is a very faithful reproduction of its larger prototype, is finely made, and runs very smoothly with either steam or compressed air, the latter being frequently used for exhibition purposes on short runs.



The following are some of the principal dimensions: 7 in. long and 3 in. high. Diameter of fly-wheel 2¾ in. Bore ⅝ in; stroke 1¼ in. It is fitted with D valve, has oil-cups on main bearings, and with the exception of the polished portions is painted an attractive shade of brown. All castings are of brass, which is the one particular in which it differs in appearance from a large engine. If a sufficient number of requests are received, castings and parts of this design will be prepared, as it in every way suitable for working up by members of the "American Society of Model Engineers." Instead of using brass, however, a non-corosive white alloy would secure a more representative appearance, and the slight addition to the expense would be more than offset by the correct color of the finished parts. If you think you would like a set of castings, express your wish by letter at an early date. This does not mean that you should send a binding order, but simply to enable an estimate of the probable number of sets needed upon which to obtain an estimate of cost from the foundry.

POISONOUS EFFECTS OF WHITE LEAD.

Consul-General Mason of Paris, furnishes a report on the agitation that has been in progress for some time in France against the use of white lead in preparing paint for industrial purposes. The consul general writes:

After many years of more or less desultory agitation and discussion the protest against the use of white lead as a material for industrial painting has assumed in this country the form and proportions of a definite and insistent measure of reform. There was held recently in the great hall of the Trocadero in Paris a meeting of scientists, philanthropists, contractors, master and journeymen painters to the number of nearly 2000, the purpose of which was to put into definite form some of the facts and statistics which show the extent and danger of lead poisoning among painters and workmen in the white lead factories, and the effects of such exposure upon the health of the workingmen and their children.

The president of the assemblage, Prof. Dieulafoy, was assisted by some of the most eminent scientists and physicians of France, among whom were Dr. Brouardel, Profs. Richelot, Chantemesse and Vidal, and a large number of practising physicians from Paris and the Departments. Among the vast assemblage were delegates from the syndicate of industrial painters in Paris, Lille, Bourges, Bourdeaux, Nantes and other cities, so that the proceedings assumed a distinctly national and representative character.

In his opening address Prof. Dieulafoy stated that it was a matter of common knowledge and experience among physicians whose practice is among people of the working class, that journeymen painters who use whitelead for interior or exterior work on buildings, as well as the workmen employed in white lead factories, are often afflicted with a long train of diseases resulting from saturnine poisoning. Among these meladies were cited saturnine colic, an intensely painful form of abdominal cramp; muscular and articular rheumatism, ending in muscular atrophy and paralysis; saturnine anemia and gout, which reduce the individual to a state of complete incapacity for labor, and finally saturnine nephritis, which disorganizes the kidneys and leads to uremia and its various epileptic, apoplectic and delirious complications.

This formidable arraignment was taken up and con-

tinued by Dr. Mosney, physician in chief at the Hospital St. Antoine, whose practice has brought him into contact with a great many cases of saturnine disease. Dr. Mosney read a letter frem Prof. Bertillion, the eminent crimonologist, who confirmed from his own experience and observation the now generally acknowledged assertion that the manufacture and use for painting of white lead constitutes two of the most unwholesome and dangerous occupations known to modern industry.

The poison attacks the system both through the lungs by inhalation in the form of fine particles of dust, and through the digestive organs when taken into the stomach with food or drink that has been cotaminated by the touch of soiled hands or exposure in an atmosphere poisoned with the dust or fumes of lead. The arraignment having been completed and driven home by statistics and scientific testimony from which there could be no reasonable appeal, the meeting took up the question of a practical remedy. This was declared to be simply the abolition by law of the manufacture and use of white lead as a painting material and its replacement by zinc white, a substitute which is superior in whiteness, equally durable, harmless to human health, and only about 1 per cent more expensive to produce.

CORRESPONDENCE.

No. 116. NEWPORT, R. I., DEC. 12, 1902.

I have read in the columns of AMATEUR WORK several articles about spark coils and interrupters. I take the liberty to ask a little advice about them. I wound up a secondary coil containing one pound of No. 36 silk covered wire run through paraffine, and the primary had two layers of No. 16 wire. The secondary was tested with a magneto, and it was found to be all right. I made an interrupter like the sketch shown below (plain lever, not shown) and the best spark I could get was about 1-16 of an inch on ten dry cells in series-multiple. Both points on the vibrator were pure platinum.

I also have a small secondary winding, rated at ⅜ in. spark, but it will not work. The condenser is variable up to 14 M. F.

I have made an interrupter like the one in the November issue of AMATEUR WORK, and it works very fast, but will not excite the secondary on the large coil. If you could suggest any method of breaking the circuit so that I could work these coils, I would be glad to have it. I can get a ¼ in. spark out of a small coil by making and breaking with a file. My large coil is very near the dimensions given in the October number. F. E. M.

In all probability your large coil has broken down inside and is short circuiting between layers. It would be advisable to rewind your No. 36 wire on a lathe or other revolving device in ½ in. sections instead of in layers, as with layers a paper insulation is required between the layers of wire. Have diameter of each disc two inches, with a 1⅛ in. hole. Separate sections 1-16 in. from each other by pasteboard discs. Put four layers of cotton cloth over the primary before placing the two windings together. Wax the cloth with hot paraffine.

The most satisfactory spark results are to be had from coils wound in sections with the proper amount of condenser, say 30 sheets of foil, size 4 x 5 in., and a vibrator 2½ in. swing. You should easily get a ½ in. spark on six dry cells arranged in series, provided the primary is well wound with d. c. c. wire, 3 layers, and the core is of soft iron wire, 2 inches longer than the secondary.

The vibrator described in the July 05 issue, (Page 223, Fig. 1) in the article, "Interruption of Primary Currents," is a very efficient one.

No. 117. ALLERTON, MASS., DEC. 5, 1905.

Please give specifications for a simple coherer for experimental use. G. T. W.

The simplest coherer would be a glass tube about 1-16 in. bore and 4 in. long, with plugs turned from brass 1-16 in. rod. The ends of the rod should be brightened by rubbing in mercury. For filings use a silver coin, after heating them to cherry red in the fire. Separate the electrodes, 1-16 in. Fill the chamber less than one-half full.

No. 118. COLUMBUS, OHIO, NOV. 30, 1905.

Will a spark coil giving 1 in. spark in one section of the country vary in results when operated with same battery and interrupter in another section?

Is it possible to communicate by wireless even when the tops of the two aerial wires on the poles are not within visual distance of each other? T. B. M.

Makers of coils prepare for climatic influence on coils by winding to give more than the rated spark. Coils which in the East give a 6 inch spark have been known to give out 7 inches in Denver and other Western cities. This is perhaps due to the lower atmospheric pressure, which enables the energy to penetrate to greater distance.

Have your poles extend in the air as far as possible above trolley and arc lights, and there will be very little other interference.

SCIENCE AND INDUSTRY.

A respiratory apparatus for firemen, invented by Mr. Charles E. Chapin, a draughtsman who lives in Berkeley, Cal., consists of a hood lined with oiled silk to cover the head and an air cylinder which is strapped on the back. The cylinder is divided into three chambers, carrying enough air under a pressure that can be regulated to last an hour. The air is conducted by

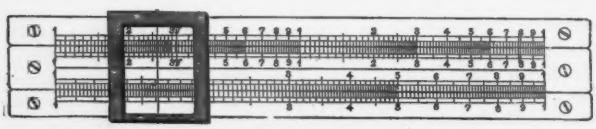
a rubber tube to the head piece, the exhaled air passing out through a valve before the mouth. The fireman can get enough air to fill his lungs comfortably, but cannot expend the supply in a short time, as he might be tempted to do if he became frightened. The main supply of air comes from the outer cylinders, the middle one being smaller and to be drawn upon only after the two others are exhausted. The apparatus can be adjusted on the bank in half a minute, and, as it weighs only 23 pounds, it does not impede the fireman in his work.

Attracted by the peculiar glitter of a boulder while hunting moonstones at Arcadia Beach, Philip J. Boyle. a California diver, is something like $1500 in pocket. Upon examination the boulder proved to be a mass of gold quartz weighing 278 pounds. It contains upward of five pounds of gold. The boulder is oval in shape and its surface has been worn smooth by the action of the waves.

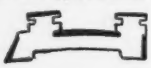
TRADE NOTES.

The Gunter scale, for decades a valuable aid to engineers, surveyors, navigators, etc., has recently been entirely superseded by the "Mannheim" Slide Rule. This has nowadays proved itself to be indispensable in every office and to everybody whose business involves calculation.

Multiplication, division, involution, evolution and arithmetical, algebraical and trigonometrical functions can be performed on this rule mechanically with the greatest ease and rapidity and without mental strain.



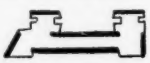
Kolesch's "Precision" calculating rule embodies a great improvement over other similar rules. It is made of the very best well seasoned built up mahogany stock with white celluloid facings. The graduations are all engine divided, clearly and accurately cut, and being on a white background are very legible. This is one great advantage of these rules over lithographed rules which are on the market, and which will wear off in a short time so that graduations and figures are illegible and indistinguishable.



The main improvement, however, is the construction of the stock or body of the rule. The rules formerly constructed with celluloid facings on the inside of the groove only are always liable, under changes of temperature, climate or humidity, to expand, contract or warp, as shown in illustrations below.

In the Kolesch "Precision" slide rule this drawback is entirely overcome by mounting the two faces of the backbone with celluloid, as shown in figure below, making the body unaffectable by changes of temperature or humidity.

The ends of the celluloid facings on these rules are secured to the wood by German silver screws, which



secure absolute adherence to the celluloid facings to the body of the rule. (See cuts above.) In order to meet every demand, these rules are manufactured five, eight, twenty inches long.

Messrs. Kolesch & Co., 128 Fulton St., New York, gladly furnish any information and descriptive prices of "Precision" slide rules, also particulars of circular calculators.

The Atwater Kent Mfg. Works, 42 North Sixth Street, Philadelphia, Pa., manufacturers of ignition specialties, have introduced a new feature in their Automatic Volt Ammeters for 1906, which are now ready for the market. This is a "Dead Beat" needle, which, on account of its quickness in coming to rest insures a quick and accurate reading.

Their meters are adapted to any work where primary batteries are used. Every meter is guaranteed absolutely accurate, hand calibrated to standardized appartus and thoroughly tested. A neat, hand-sewed leather case is furnished with each instrument. Price, 0-5 volts, 0-20 amperes, $5; 0-10 volts, 0-20 amperes, $7. Their voltmeters, which are the same in appearance as the Automatic Volt-Ammeters, but without button attachment, also have this excellent feature of the "Dead Beat" needle. Price, 0-6 volt, $5; 0-10 volt, $6. Price of ammeter, 0-10 amperes, $5; 0-25 amperes, $6; 0-30 amperes, $7. Meters with special reading up to 30 volts and 30 amperes, are made to order. These are very convenient and fully meet the requirements of automobile and gasoline engine users.